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Experimental evaluation of demonstrations in teaching vocational agriculture

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EXPERIMENTAL EVALUATION OF DEMONSTRATIONS
IN TEACHING VOCATIONAL AGRICULTURE

by

Sidney Dean Borchert

A Dissertation Submitted to the
Graduate Faculty in Partial Fulfillment of
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Approved:

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INTRODUCTION

The twentieth century has brought about a technological revolution in the United States and in much of the rest of the world. This revolution has come about as a result of extensive scientific discoveries and other innovations that have allowed man to conquer space and set foot on the moon. With the increasing amounts of knowledge in the world today, pressure has come about to find more effective and efficient methods of instruction for conveying the increasing volumes of knowledge. This influence has motivated the development of many new and innovative instructional methods and approaches aimed at increasing the effectiveness of our educational system.

Agricultural education has felt the need for more effective instructional methods as well as other segments of the educational system. The challenge of keeping agricultural workers abreast with the new innovations in technology that are necessary if they are to continue to produce efficiently and profitably has been coupled with the enactment of Public Law 88-210, the Vocational Education Act of 1963. This law broadened and revised the objectives of vocational agriculture to include preparation and training in any occupation involving knowledge and skill in agriculture, the concomitant objectives of occupational exploration, guidance and counseling, and the development of abilities essential for effective citizenship. This expansion of objectives and increased technology has accentuated the need for improvement in instructional methods in agricultural education.

Experimental studies designed specifically to evaluate the

effectiveness of instructional materials and methods are lacking but are much needed in agricultural education (28). Recent developments in agricultural education relative to instructional materials and methods may be classified into three major categories; (1) the development and evaluation of programmed instructional materials, (2) experiments designed specifically to evaluate instructional materials, and (3) the development and evaluation of instructional materials relating to nonfarm agricultural occupations (28).

There is no shortage of literature describing materials and devices which have been developed and tried by specific teachers with specific classes. Most of these descriptive approaches do not constitute research. There is a need for experimental tests of the efficiency of these approaches as compared to alternate approaches (26).

The findings of research pertaining to learning processes and teaching methods, singularly or collectively, provide only in part a basis for development and refinement of theory and practice concerning teaching and learning in agricultural education. A plausible explanation for this lack of "sense of direction" in this area may be that in development of a promising method or technique definition and refinement are required through experimentation and investigation prior to the time it is subjected to rigorous evaluation in an experimental setting. Only after this has been done it is appropriate to conduct an experimental evaluation of the proposed technique or method (28).

An ancient philosopher has said, "One picture is worth a thousand words." By implication, if the picture and words were both presented, then the importance of the event would be more clearly seen, more easily

explained, more readily understood. Bodenhamer (3) found that voluntary adult audiences, when presented an informative speech which was supplemented with visual aids, learned significantly more when tested for immediate recall than audiences given the same informative speech without visual aids. A demonstration is a successful teaching method in that it attempts to fulfill both criteria--picture and words.

The well organized, skillfully presented demonstration lesson will stimulate the student's senses of sight, hearing, touch and sometimes smell; motivating him with a desire to practice, encouraging him to perfect his own skill. The skillful demonstration will attract and hold the student's attention and interest because he can visualize how this procedure will personally benefit him.

Webster defines the demonstration as "public showing emphasizing the merits, utility or efficiency of an article or product." A definition pertaining more to a method of instruction for the demonstration is "a visualized explanation of a process, procedure, idea or concept that is presented in a logical step-by-step procedure." When possible the demonstration should be given using the actual objects and materials. When this is not possible or adequate, visual aids should be used to supplement or replace the actual objects or materials in the demonstration.

Nail (19) pointed out that along with being psychologically and educationally sound, the demonstration accomplishes some important immediate objectives. If a new practice or technique is adequately demonstrated, there will be less waste of expensive materials. The teacher can teach more students at a given time. The demonstration is therefore economical

as it conserves the teacher's time, students' time, and materials and equipment.

Demonstrations have been used as an instructional technique in vocational agriculture most effectively in the teaching of agricultural skills that require psychomotor skills, however, wholly abstract subject matter can be demonstrated effectively. The method demonstration has been used very little as an instructional technique in areas other than farm mechanics in vocational agriculture. Little research has been conducted in these areas to evaluate the effectiveness of demonstrations as an instructional technique.

The purpose of this study was to evaluate the effectiveness of demonstrations as an instructional technique in teaching prescribed subject matter to vocational agriculture students in Iowa high schools. This purpose was restated in the form of general objectives. They were as follows:

1. To determine the effectiveness of demonstrations as an instructional technique in teaching vocational agriculture.
2. To determine the factors related to student achievement in vocational agriculture when demonstrations were used as an instructional technique.

The study was conducted by the author as a segment of a larger experimental project entitled "An Experimental Evaluation of the Effectiveness of Selected Techniques and Resources on Instruction in Vocational Agriculture." The selected techniques were: audio-tutorial, demonstrations, field trips, prepared lesson plans, single concept films, transparencies

and video tape. The project was conducted in cooperation with the Department of Agricultural Education and the Iowa Agriculture and Home Economics Experiment Station of Iowa State University, the Vocational Agriculture Section of the Department of Public Instruction and the Iowa Research Coordinating Unit.

This study was financed in part by funds from the Iowa Agriculture and Home Economics Experiment Station, but largely by funds from the Research Coordinating Unit under a research grant from Vocational Education Branch (VEA - 1963-1964 (a) ancillary funds) Iowa Department of Public Instruction.

REVIEW OF LITERATURE

Much has been written in educational textbooks and publications concerning the preparation and use of demonstrations in vocational agriculture. However, very few experimental studies designed specifically to evaluate the effectiveness of demonstrations in vocational agriculture or other curriculum areas have been reported. As a result, this review has been divided into three parts; (1) value of demonstrations in teaching, (2) preparation and conduct of demonstrations and (3) review of related experimental research.

Value of Demonstrations in Teaching

The values of effective demonstrations are given by Brown, Lewis and Harclerod (4, p. 316):

Demonstrations focus attention and dramatize important basic steps and procedures. By reducing the length of the trial-and-error period, learning time may be reduced and fixations of wrong ideas avoided. Demonstrations provide functional practice for students who seek to improve their ability to observe accurately and completely. The speed and complexity of demonstrations may be geared to the ability levels of groups instructed. In some cases, hazards may be reduced by presenting demonstrations rather than allowing students themselves to experiment, as, for example, a demonstration of the effects of nitric acid upon copper. For many instructional activities, cost of materials is an important factor - often determining whether or not the experience will be provided in the curriculum. A single demonstration by the instructor may reduce costs, as, for example, in the case of the electrolytic coating of copper bar by silver. Finally, demonstrations help to socialize learning experiences when there are provisions for interplay of ideas, observations, and comments from students.

In a national study of the education of veterans in farming, 5,274 veterans in 42 states were surveyed (16). In analyzing the data with respect to the veterans' responses concerning their satisfaction with

educational activities, it was found that class discussion, individual instruction on farms, demonstrations by the regular instructor and lecture by the regular instructor were the methods of instruction preferred by most veterans.

Other teaching procedures which 65 percent or more of the veterans liked "very well" were: use of visual aids, group instruction on farms, practice in agricultural jobs, and instruction by specialists. The following methods were given the highest ranking by 61 percent or fewer of the veterans: demonstrations by specialists, practice in farm mechanics jobs, supervised study and demonstrations by members of the class.

A comparative study of institutional on-farm training for veterans in the central region (5) found that demonstration and discussion methods of classroom instruction were rated highest in each state as shown by the mean scores of the farmers surveyed. Both the veterans instructors and the teachers of vocational agriculture agreed with the trainees in rating the demonstration method highest. Both groups of instructors rated the lecture method as the least effective method among those being rated.

The findings of this study implied that more use should be made of demonstrations and discussion methods by veterans instructors and teachers of vocational agriculture. These methods should also be given greater emphasis in pre-service and in-service training.

In surveying the opinions of veterans enrolled in the veterans farm training program, Hamilton (12) found that 73.7 percent of the veterans surveyed rated demonstrations as a good method of instruction. Twenty and six tenths percent rated demonstrations as a fair method, whereas only 1.5 percent rated it as a poor method of instruction.

A chi-square value (22.0532) was obtained in comparing the good and fair responses indicating there were significant differences in the responses of the veterans concerning the demonstration method of instruction. The responses revealed that this method of instruction was desired by most veterans in all eleven states participating in the study.

It was also found that the demonstration and discussion methods were the preferred methods of classroom instruction. Hamilton therefore suggested that more emphasis might be placed upon the use of these methods.

Warren (29) surveyed the opinions of veterans enrolled in the institutional on-farm training program concerning the value of audio-visual materials and methods and the extent to which they should be used in an effective instructional program of agricultural education for adults. The mean score of 1.69 for demonstrations was highest when evaluating the extent to which ten audio-visual materials and methods should be used in an effective instructional program. Over 95 percent of the veterans indicated that "much" or "some" use should be made of demonstrations. A nonsignificant chi-square value (1.94) was obtained, evidence that the extent to which demonstrations should be used in an effective instructional program was not related to the ratings of instructors.

The use of demonstrations is further substantiated by Morgan, Holmes and Bundy (18, p. 124):

The demonstration method when properly selected and used, may be very effective. It is not a universal method, however and should not be used in all teaching situations any more than a single drug should be used for all ills. Demonstrations are most likely to be successful (1) in teaching manipulative and operational skills, (2) in developing understandings, (3) in showing how to carry out new practices, and (4) in securing the acceptance of new and improved ways of doing things.

Preparation and Conduct of Demonstrations

The planning and preparation of a demonstration by the teacher is crucial to the success of the demonstration. This is emphasized by Nail (19, p. 68):

The potentialities of the demonstration are unlimited, these potentialities cannot, however be fully realized by the teacher of vocational agriculture unless he plans carefully and well. Planning and preparation are probably more important when using the demonstration than with most other means of teaching because the teacher must be familiar with the steps in the process or practice to be demonstrated in addition to knowing his subject from the standpoint of knowledge and background.

There are two kinds of demonstrations as defined by Morgan, Holmes and Bundy (18); the method demonstration and the result demonstration. Method demonstrations show how to do something. They involve the use of the equipment and materials actually used in the job being taught. Method demonstrations show what is done, how it is done, explain each step as it is taken, can usually be completed in a relatively short time, and do not cost much to give. Result demonstrations may cover a considerable period of time and be rather expensive. This particular study was limited to the study of the method demonstration and therefore no discussion or review of result demonstrations will be included.

The following keys to preparation of successful demonstrations were suggested by Weaver (30): Anticipate those steps which may cause the greatest difficulty and provide, or have ready, some form of supplemental instruction to clarify the point. Remember to give short demonstrations to avoid fatigue of students and to help the retention of the material presented. Remove all possible distractions before the demonstration begins.

In discussing the points to be considered when giving a demonstration, O'Brien (20, p. 10) stressed that in order for a demonstration to be successful it must do a complete job of teaching. He stated that:

It must be realized that the demonstration is more than simply showing a student or group of students how a job should be done. In addition to helping the students understand difficult and complicated procedures, it should be planned and executed so as to lead to a complete job of teaching. A complete job of teaching the manipulative part of farm mechanics does not end with the student being told, thinking through the problem, and seeing the job done. It also includes his doing the job; being checked, corrected, and measured on his understanding and the performance of the job; and, in addition, the application by the student of what he has learned.

Preparation of the classroom method demonstration has been broken into six parts by Dale (7):

1. A demonstration is a dramatic performance.
2. Plan every step (including materials) carefully.
3. Rehearse your demonstration.
4. Outline the steps on the chalkboard.
5. Be sure that everyone can see and hear.
6. Prepare written materials.

The following outline was found usable by Dean (8) for the presentation of the demonstrations developed in his study; (1) title and purpose of the demonstrations and (2) procedure and thought provoking questions. Frazier (10) used a more detailed outline in the preparation of the demonstrations developed in his study. He used the following outline; (1) title and purpose, (2) materials needed, (3) step-by-step procedure, (4) interest provoking questions and remarks and (5) conclusions.

The procedure outlined by O'Brien (20) for the instructor to follow in

preparing and conducting a demonstration can be summarized as follows:

1. State the objectives of the demonstration.
2. Divide the job into easily explained and logical steps.
3. Know the job - rehearse the demonstration before presenting it to the class.
4. Have all necessary equipment and materials on hand before the start of the demonstration.
5. Place students so that they can all see the demonstration.
6. Anticipate difficulties that students may have and plan to give particular attention to them.
7. In most cases the instructor's demonstration should not last more than 20 to 25 minutes.

Review of Related Experimental Research

Little research has been done to specifically evaluate demonstrations in agricultural education or in any other area of education. The following review of literature presents those experimental studies pertinent to this study.

Factors affecting learning from a demonstration were experimentally tested by Worthington (32). The basic hypothesis evaluated was that speed of learning an assembly task by delayed imitation is affected by (1) demonstration, (2) the task, by (3) verbalization of key elements of the by the demonstrator, (4) by difficulty of the task and (5) by the elapsed time between demonstration and application. The design consisted of 112 subjects randomly assigned to 14 experimental groups. Seven of the groups

used complex assembly tasks and the other seven groups used simple assembly tasks.

The major findings of his study were as follows: (1) instruction with demonstrations significantly reduced the time required to learn the assembly task by delayed imitation; (2) the demonstration reduced the time required to learn the complex task to a much greater degree than it did to learn a simple task; and (3) verbalization of key elements accompanying a demonstration did not significantly reduce the time required to learn the simple or complicated task.

When comparisons were made among subjects having a demonstration the following conclusions were made: Factors of verbalization and delay did not effect speed of learning; and the lack of significant correlation between time scores and contrast variables indicated that the demonstration as presented in the study equalized the effects of intelligence, mechanical ability and chronological age.

An experimental comparison to determine the effectiveness of the use of instruction booklets and demonstrations was conducted by Hofer (13). Fifty seventh-grade boys were taught four metal working operations by alternate methods of instruction under the direction of the researcher. The four operations taught were foundry copper enameling, drilling, counterboring and threading. Each student was instructed on how to perform two groups of operations by demonstrations and the other two operations were taught via the instruction booklets with the student performing the operation as he read his instructions.

It was observed that demonstrations which were followed immediately by performance required less student time for instruction than did the

self instructional materials. However, self instruction materials were found to produce slightly higher achievement than demonstrations with respect to the amount of terminology and knowledge of procedure learned and retained. No attempt was made to specifically measure the differences in achievement by students with different intelligence and reading ability levels.

The use of teacher produced instructional films was compared with teacher demonstrations in teaching perceptual-motor skills by Snyder (23). Two junior high school industrial arts class sections comprised each treatment group with a total enrollment of thirty-two students. Both groups were equated in relation to reading ability, mechanical ability and previous industrial arts experience. The projects constructed by the students were evaluated by a jury of industrial arts educators in order to determine the effectiveness of the two methods of instruction.

It was found in 32 of the 43 operations evaluated by the jury, that the students in the two instructional groups did not differ in their performance of the specific perceptual-motor skills. However, the jury's evaluation of the remaining 11 operations found that students taught with teacher demonstrations scored significantly higher than those students taught with teacher produced instructional films. This demanded the rejection of the hypothesis that students of the two groups did not differ in performance indicating better workmanship was performed by the students of the demonstration group. Snyder concluded that the influence of the personal contact between the demonstrator and the students during a live presentation cannot be overlooked.

An attempt to ascertain the relative superiority of teacher

demonstrations and shop activities in the teaching of general electricity on the college level was made by Johnston (15). Six classes involving 106 students were divided into two groups which studied the same informational content but were taught with different instructional methods by the same instructor. The one group was taught with teacher demonstrations and the other by means of shop activities. For purposes of comparing educational outcomes, 38 pairs of students were matched on mental ability and initial status in the subject. Informational achievement was measured by means of a subject matter test administered at the completion of the course.

The following findings were revealed in comparing the two instructional methods: (1) the teacher demonstrations were found to be superior to shop activities insofar as the acquiring of information was concerned; (2) with respect to the cost of teaching the course, the expense involved in the use of the demonstration method was found to be less than that of the shop activity method; (3) the demonstration method was found to require less teacher effort in the preparation and teaching of the classes than the shop activity method; and (4) no significant difference was found to exist between the two groups as to attitudes expressed toward the subject when taught by the respective methods.

Based on his findings, Johnston concluded that teacher demonstrations of electrical principles and applications are superior to, or more effective than shop activities in the teaching of general electricity to industrial education students at the college level. It was also recommended that more demonstrations of principles and applications be provided in the teaching of electricity.

A study to compare the effectiveness of four selected instructional treatments measured by judges' ratings of student's performance on four selected manipulative tasks was conducted by Calder (6). The four selected instructional methods were self instruction, lecture-demonstration (classroom), lecture-demonstration (television), and no-instruction methods of teaching manipulative skills. A four-by-four counterbalanced Latin square design was employed to control some of the variables and criticisms of classroom experimentation. Groups, teachers, tasks and treatments were randomly assigned. The four groups of subjects were selected from a population of college juniors and seniors.

Subjects taught by the self-instruction and no-instruction methods were given no verbal procedural-instructions. The self-instruction treatment group was given written procedural steps, whereas the no-instruction group learned by a trial and error procedure. The lecture-demonstration groups received 20 to 25 minutes of verbal and illustrated instructions. Teachers were not allowed to assist subjects or answer questions during subject's performance on the tasks. Analysis of variance was used to analyze the results of the Latin square design.

Statistical analysis resulted in the failure to reject the hypothesis that there were no differences in times required to perform manipulative tasks taught by self instruction, lecture-demonstration (classroom), lecture-demonstration (television), and no-instruction methods of teaching manipulative activities. However, the hypothesis of no differences in quality of performance of groups taught by the four instructional treatments was rejected. Based on quality of performance the instructional treatments were ranked as follows: self-instruction first, lecture-

demonstration (classroom) second, lecture-demonstration (television) third, and no-instruction fourth.

The purpose of a study conducted by Ricker (21) was to provide formal research evidence as to the effectiveness of four selected methods of presenting a unit on magnetic properties. The four methods were lecture only, lecture and teacher demonstration, lecture and student experimentation, and lecture and programmed learning. The population consisted of 427 students enrolled in six physical science classes. The design consisted of a pre, post and retention tests to reassess the ability of the student to relate his knowledge about magnetism. The tests were constructed and administered by the researcher to determine the relative effectiveness of the four different methods of teaching the unit on magnetism. Analysis of variance of gain scores was used to determine the variability among the four groups studied.

Analyses of the data resulted in no significant differences. There were no significant differences among the scores of the students in the four groups with respect to pre-test or total gain scores as indicated by the difference between the pre-test and post-test scores. No difference was found among the retention gain scores of the subjects in the four groups or between the pre-test and retention test. Stratification of students into three ability groups resulted in no significant differences among the levels of ability according to treatment on the gain score or on the retention score.

Based on the analysis of the data as far as learning was concerned, the four methods were equally effective. Ricker therefore concluded that since the methods appeared to be equally effective, the one requiring the

least amount of the instructor's and student's time was considered to be the most efficient. In this respect, the lecture only approach, was the most desirable.

The achievements of students in physical science classes when taught by lecture-demonstrations and group study were compared by Ward (27). In the lecture-demonstration method, the instructor assumed all responsibilities for class activities, the lectures and demonstrations, and for all grading. In the group method, the same instructor provided opportunities and the responsibilities for the students to formulate their own objectives, activities and grading procedures. The same measuring instruments were used in evaluating the achievement of both groups immediately following the treatment period. A re-test was administered six months later. Analysis of covariance was employed to equate the groups on two initial measures of individual differences among the students, ACE-Q scores and pre-test scores.

The findings revealed that the lecture-demonstration method produced better immediate results with respect to more understanding of facts, principles, and symbols than did the group method in the cases of those students who achieved below the upper quarter on the ACE-Q tests. However, no difference was found for the upper quarter achievers on the ACE-Q tests.

The group method produced relatively longer-retained results with respect to the understanding of terms than did the lecture-demonstration method when comparing students who achieved in the middle one-half on the ACE-Q tests. No differences were found when comparing the upper and

lower quarter achievers on the ACE-Q tests with respect to retention of understandings.

The lecture-demonstration method resulted in greater expression of individual differences on the understanding of terms than did the group method in the cases of the least capable students. The lecture-demonstration method also resulted in greater expression of individual differences on the recall-recognition items than did the group method in the cases of the less capable students.

Learning outcomes of the lecture-demonstration and the illustrated-lecture methods of instruction were compared by Gale (11). The subjects for the experiment were students in the Hydraulic Mechanics Course at Chanute Air Force Base, Illinois. A randomized block type experiment, with equal subclasses, was used. The balanced design consisted of two pair of instructors teaching one-half of the students by the lecture-demonstration method and one-half the students by the illustrated-lecture method. Simple training devices were taught one week to one group of students and complex training devices were taught in the second week to a different group of students. Two different instructors were used for each week of instruction. Written and performance tests were used to evaluate the methods at the end of each week.

Analysis of covariance was used to control the effects of the students' previous knowledge of the field as measured by the tests used. The analysis revealed that the lecture-demonstration method as used in the Hydraulic Mechanics Course resulted in significantly higher performance by the students than the illustrated-lecture method in teaching simple

performance skills. No difference between the two methods was observed when compared on students performance of complicated tasks.

The teaching methods had a measurable influence on the written test outcomes when simple training devices were used but no measurable difference when complex training devices were used. In as much as the Air Force Technical School was interested in the development of performance skills, Gale concluded that the lecture-demonstration method was superior.

The effectiveness of a conventional face-to-face demonstration with a closed circuit televised demonstration on trouble-shooting utilizing a particular kind of volt-ohm meter was studied by Horning (14). His findings revealed that conventional face-to-face classroom demonstrations were as effective as the closed circuit television method. He also observed that the inexperienced instructor could improve the effectiveness of his demonstration through the use of the television media.

Folley et al. (9) taught military trainees to assemble and disassemble the M1 Carbine using the lecture-demonstration approach, a printed linear program and an audio-visual program. Results indicated that the lecture-demonstration was equally effective to the other two methods used.

Twenty-two studies illustrative of the "SNAFU" regarding teaching methods in industrial education were reviewed by Suess (24). The studies cited revealed that programmed instruction and lecture-demonstration yielded equal immediate performance and retention. Comparisons of the visual-aids mode of teaching to the demonstration approach showed no differences in the effectiveness of the two techniques. However the

comparison of demonstrations to lectures showed that the demonstrations were more effective and efficient.

A companion study to the one conducted by the author was completed by Beane (1) as a part of the larger project entitle "An Experimental Evaluation of the Effectiveness of Selected Techniques and Resources on Instruction in Vocational Agriculture". The purpose of his study was to determine the relationship between the instructor's level of knowledge of the subject matter and the student's level of academic achievement.

Iowa high schools offering an approved four-year program of vocational agriculture were identified and a random sample of 48 high schools were selected to participate in the experiment. Each of these 48 high schools was randomly assigned to one of eight treatments: Audio-tutorial, demonstrations, field trips, prepared lesson plans, single concept films, transparencies, video-tape and control.

Instructional materials for the eight treatment groups were prepared by the members of the project staff for each of the four subject matter areas. The subject matter areas were animal health for the ninth grade students, commercial fertilizers for the tenth grade students, small gasoline engines for the eleventh grade students and farm credit for the twelfth grade students.

Student achievement was measured by the use of a pre-test and post-test in each of the four subject matter areas. A pre-test was administered to the vocational agriculture instructors prior to their receipt of the instructional media treatments in each of the four subject matter areas. The same test was again administered as a post-test upon completion of the instructional period. Based on their pre-test scores and gain

scores from the pre-test to the post-test scores, the instructors were placed in three groups of high, medium and low. Analysis of variance and t-test procedures were used to evaluate relationships between instructors' knowledge of the subject matter and student achievement.

The findings revealed significant differences among the mean post-test scores of students grouped according to their instructors' knowledge of the subject matter for the composite of subject matter and for the farm credit unit. In the composite of subject matter, and in the animal health, commercial fertilizers and farm credit units, the highest mean post-test scores were achieved by students whose instructors were in the medium group. In the small gasoline engines unit the highest mean scores were made by students whose instructors were in the low group.

A highly significant difference was found between the instructor's pre-test and post-test mean scores. In the small gasoline engines unit there was a significant difference in post-test mean scores among students grouped according to their instructors' change in knowledge. The highest mean score in small gasoline engines unit was calculated for students whose instructors were in the low instructor group.

Another study as a part of the larger project previously mentioned was made by Tindall (25) to determine the relationship of class size and department enrollment to the achievement of students in high school vocational agriculture in Iowa when certain selected instructional media are used. Tindall's procedure was similar to Beane's (1) except that neither the six schools in the control group or the tests relating to the instructor's knowledge were used. The 42 vocational agriculture departments included in the study were divided into enrollment groups of 36 to

53 and 54 to 79 students. The classes were divided into two groups, 5 to 14 and 15 to 25 students per class. Data on the tenure, experience and education of the instructors were obtained.

When comparing the gain in achievement of students in animal health and farm credit subject matter in schools stratified by department enrollment and instructional media, it was revealed that the students in large departments had higher achievement when demonstrations were used. However, students in small departments scored higher than the students in larger departments when taught with demonstrations in the commercial fertilizer and small gasoline engines subject matter units.

When stratifying by class size it was found that students in the smaller classes had higher achievement when instructed with demonstrations in the animal health, commercial fertilizer and small gasoline engine units. Students in large classes achieved better than those in small classes in the farm credit unit taught by demonstrations. These differences were not verified as statistically significant.

A related study by Klit (17) evaluated in depth the single concept film treatment. He attempted to experimentally evaluate the effectiveness of single concept films as instructional aids as a segment of the overall study previously mentioned. The six schools randomly assigned to the single concept film group and the six schools assigned to the control group were compared. Twenty-one single concept films were produced and used in teaching the four specified subject matter units in the single concept film treatment group.

The results of Klit's study are summarized in the following statements:

1. The students in the treatment and control schools were similar in prior knowledge of the subject matter before the three-week experiment began.
2. The differences in achievement between the treatment and control groups were not significant for the commercial fertilizers, small gasoline engines and farm credit units. In the animal health unit the control schools had a greater magnitude of change.
3. In comparing the achievement of the classes taught with the aid of single concept films to those taught in a traditional manner, no significant differences were found between the achievement of the two groups as measured by the post-test scores.
4. The students with the highest pre-test, intelligence, verbal aptitude and agricultural achievement scores performed best when taught with single concept films. The same types of students achieved best in the control schools also.

In a study similar to Klit's (17), a detailed analysis of the effectiveness of projected transparencies on instruction in vocational agriculture was conducted by Bendixen (2). The study was also a part of the experimental project entitled "An Experimental Evaluation of the Effectiveness of Selected Techniques and Resources on Instruction in Vocational Agriculture". A secondary purpose of his study was to determine the effectiveness of color when used on overhead projected transparencies. The six schools randomly assigned to the overhead projected transparencies treatment and the six schools in the control group were compared with respect to the mean student achievement on the post-test.

The findings revealed no significant difference between the pre-test scores of the two groups in each of the four subject matter areas. No significant difference was found between the treatment and control groups of schools using composite mean post-test scores for the four subject matter areas. Analysis of each of the four subject matter areas separately, also revealed no significant differences between the treatment and control groups as measured by student mean post-test scores.

In analyzing the various types of transparencies used, no significant differences were found between the three types of transparencies used. No significant differences were found between factors related to student achievement in the overhead projected transparencies group and the control group. Results did indicate that agricultural achievement, verbal aptitude and intelligence quotient scores were the most reliable predictors of student's academic achievement on the post-test scores in the four subject matter areas used in this study.

The research reviewed indicated that no one teaching method was found to be superior to all others in all teaching situations. However, it was shown that some methods were more efficient than others in certain types of instructional programs. One of the methods that was shown to be effective and more efficient in relation to teacher preparation time, student learning time, and cost was the demonstration method.

METHOD OF PROCEDURE

This study was designed as a part of a larger experimental project which investigated the effectiveness of selected resources and techniques on instruction in vocational agriculture. The primary purpose of this investigation was to evaluate the effectiveness of demonstrations as an instructional technique in vocational agriculture by comparing instruction using demonstrations with instruction without the use of demonstrations on the same units of subject matter. A secondary purpose of the study was to determine the factors related to student achievement in vocational agriculture when taught using demonstrations as an instructional technique.

The specific objectives of the study were as follows:

1. To determine the effectiveness of demonstrations as an instructional technique in teaching animal health.
2. To determine the effectiveness of demonstrations as an instructional technique in teaching commercial fertilizers.
3. To determine the effectiveness of demonstrations as an instructional technique in teaching small gasoline engines.
4. To determine the effectiveness of demonstrations as an instructional technique in teaching farm credit.
5. To determine the factors related to student achievement in vocational agriculture when demonstrations were used as an instructional technique.

Selection of Sample

A list of all eligible Iowa high schools offering an approved program of vocational agriculture was identified. To be eligible for inclusion in the study the following criteria had to be met by the schools:

1. The approved vocational agriculture program had four separate day classes for the high school students.
2. The vocational agriculture department had a total enrollment of at least 35 students.
3. Each of the four classes in the department had a projected enrollment of not less than eight or more than 22 students.
4. The vocational agriculture instructor had at least one year of teaching experience in Iowa.

From the list of qualified schools, a table of random numbers was used to randomly assign six schools to the demonstration treatment and six schools to the control groups. Each school was then contacted by the researcher to explain the purposes of the study and obtain the consent of the school to be included in the project.

The geographic locations of the six treatment and six control schools are shown in Figure 1. The six schools in the demonstration group and the instructors in each school were as follows:

Algona -- George W. Sefrit

Corning -- Wayne A. Kordick

Denison -- Donald M. Swafford

Lake City -- Rudolph E. Engstrom

Osage -- Lewis G. Lauterbach

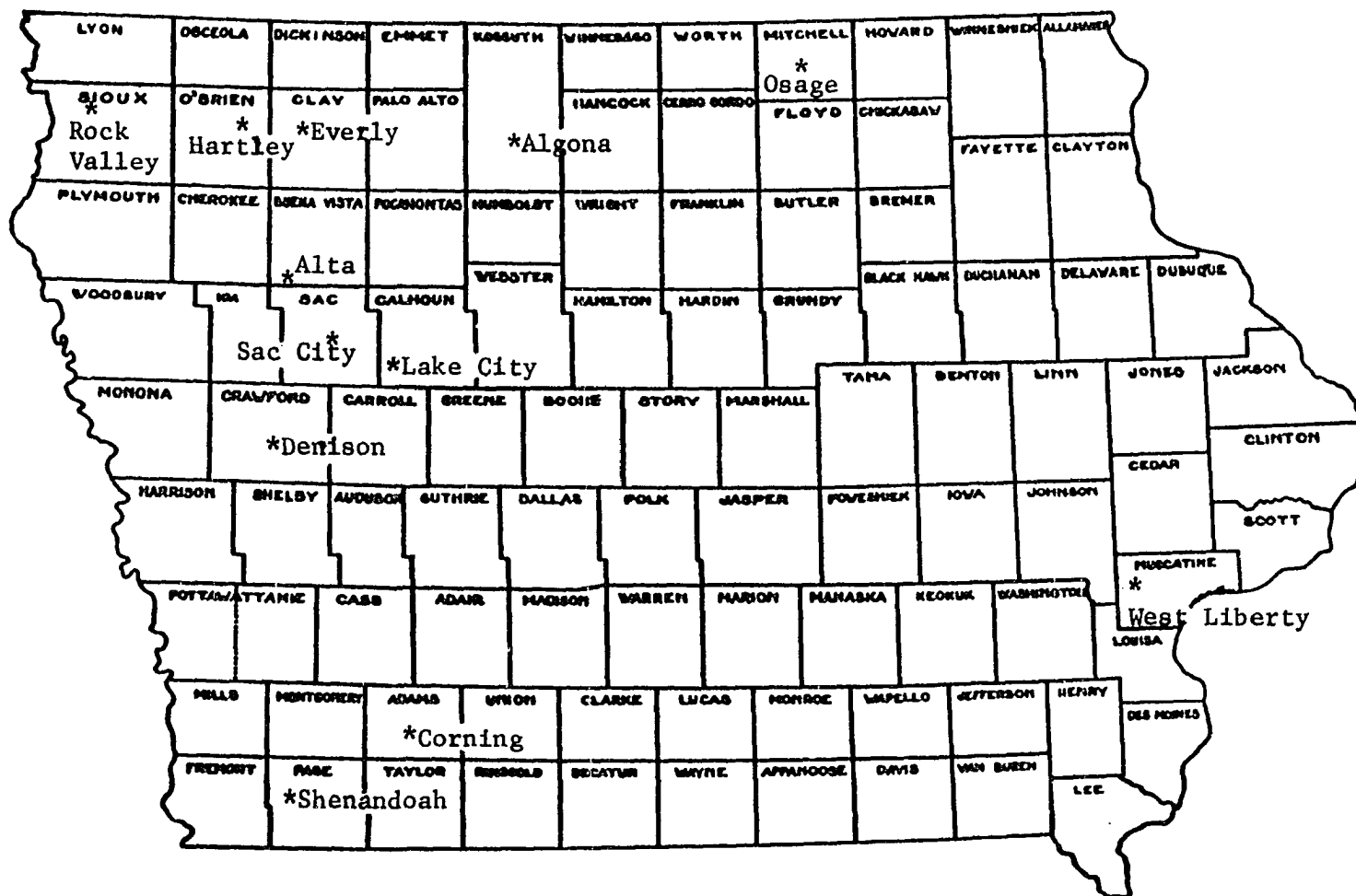


Figure 1. Geographical location of participating schools

Shennandoah -- Allen A. Carrell

The six control group schools and the instructors in each school were as follows:

Alta -- Harold L. Carstens

Everly -- Dale Fisher

Hartley -- Harold E. Woodard

Rock Valley -- Donald Kaberna

Sac City -- Larry L. Reding

West Liberty -- Richard S. Wehde

The class enrollment and size of the vocational agriculture departments within the treatment and control groups are presented in Table 1.

Preparation of Materials

An appropriate subject matter unit was selected for each of the four grade levels. The subject matter areas selected were: animal health for the ninth grade, commercial fertilizers for the tenth grade, small gasoline engines for the eleventh grade and farm credit for the twelfth grade. Following is a brief description of each of the four subject matter areas selected:

1. Animal health - The identification, causes, prevention and control of major swine, sheep and cattle parasites and diseases.
2. Commercial fertilizers - The study of the essential plant food elements, crop hunger signs, soil sampling, liming, fertilizer application rates and selection of fertilizers.
3. Small gasoline engines - The principles of operation of two and four-stroke cycle engines, functions of engine parts, measuring

Table 1. Number of students participating in the experiment by school and subject matter

	Number of students				
School	Animal health	Commercial fertilizers	small gasoline engines	Farm credit	Total
<hr/>					
Demonstrations:					
Algona	5	9	13	8	35
Corning	25	13	21	13	72
Denison	17	17	14	8	56
Lake City	14	16	8	13	51
Osage	16	14	17	8	55
Shenandoah	24	12	11	6	53
Total	101	81	84	56	322
Control:					
Alta	12	7	8	8	35
Everly	7	9	9	11	36
Hartley	12	8	10	9	39
Rock Valley	10	9	8	10	37
Sac City	10	8	14	8	40
West Liberty	16	10	10	9	45
Total	67	51	59	55	232

devices and preventive maintenance on small gasoline engines.

4. Farm credit - Budgeting principles, types of loans, sources of credit, interest rates, collateral, credit instruments and the use of farm credit.

A three-week teaching outline was developed for each of the four subject matter units which included specific day-by-day objectives and student reading assignments (Appendix A). Uniform reference materials were also provided for all schools in the project so that the only variation in instruction was the use of the demonstrations in the treatment group.

Demonstrations were developed for each of the four subject matter units by the researcher. For the purposes of the study, a demonstration was defined as "a visualized explanation of a process, procedure, idea or concept that is presented in a logical step-by-step procedure." Using the foregoing definition as a guide, demonstrations were developed in each of the four subject matter areas where the demonstration method could be effectively used as a teaching technique.

Thirty-nine demonstrations in all, including the use of actual materials, objects, mock-ups, charts and specimens, were developed for classroom presentation. Five demonstrations were prepared for the animal health unit, nine for the commercial fertilizers unit, nine for the small gasoline engines unit and six for the farm credit unit. Each demonstration was limited to a single concept or idea and could be demonstrated in 10 to 20 minutes. Students were given printed copies of the major steps and key points for each demonstration immediately after observing the demonstration.

The teaching outlines for each of the demonstrations that were

prepared and given to the instructors in the treatment group were presented in Appendix B. The teachers were also provided with the materials, objects, mock-ups, charts and specimens that were needed in conducting the demonstrations.

Training of Teachers

The participating teachers received two training sessions prior to the experiment. The first meeting was held at selected locations throughout the state to explain the purposes and design of the study and explain the controls imposed on the experiment. Data were also collected on teacher tenure, experience, attitude and education level. Student testing materials were also discussed and distributed to the guidance personnel of the participating schools at this first meeting.

The second meeting was a two-day training period held on the Iowa State University campus just prior to the experimental period. At this meeting the instructors received the three-week teaching outlines for each of the four subject matter areas and were briefed on the limitations imposed on the instructional methods and materials they could use. The only major difference in the instructional methods of the treatment and control groups was the use of the prepared demonstrations by the treatment group. The control group was not allowed to use demonstrations.

During the second meeting the researcher spent one day instructing the teachers in the treatment group on how to conduct the demonstrations they were to use. The teaching outlines for the demonstrations were explained carefully and each demonstration was actually presented to the

teachers by the reseacher. The control schools were also informed of what they could and could not do while teaching the four units.

The experiment was conducted during a three-week period beginning March 24, 1969. During this period, the author visited all the treatment schools to supervise the use of the demonstrations and evaluate the progress of the experiment. Beane (1) and Tindall (25) visited the control schools during this same period of time.

Collection of Data

Students in the experiment were administered a battery of tests to obtain pertinent descriptive information. The testing program was spread throughout the two months prior to the experiment. The following tests were administered to all students in the project by the guidance directors in each of the cooperating schools:

1. Otis Quick-Scoring Mental Ability Test
2. Kuder General Interest Survey
3. Nebraska Agriculture Achievement Test
4. Differential Aptitude Test - Mechanical Section
5. Differential Aptitude Test - Abstract Section
6. Differential Aptitude Test - Verbal Section

A questionnaire was also administered to obtain data on the student's socio-economic background.

A 60-item test was developed for each subject matter area by Iowa State University Department of Agricultural Education staff members. This test was used as a pre-test and again as a post-test. Each of the

test questions stressed one of the specific objectives listed in each of the four subject matter teaching outlines.

All of the students involved in the study were given the pre-test just prior to the beginning of the three-week instructional period and the post-test upon completion of the instruction period. Both the pre-test and post-test were administered by the guidance directors in the respective schools to prevent the teachers involved from seeing the post-test until after the instructional period.

The four subject matter post-tests were item analyzed and the reliability of each test was computed using the Cronbach alpha formula. They were as follows:

1. Animal health -- .85
2. Commercial fertilizers -- .85
3. Small gasoline engines -- .85
4. Farm credit -- .87

Analysis of the Data

Individual student information collected from the 12 cooperating schools along with pertinent data obtained on the teachers involved in the study were coded and punched on 80-column data processing cards. From these cards, class means were calculated and also punched onto cards.

Since schools were randomly assigned and not students, class means became the experimental units and were the observations used in all comparisons of the treatment and control groups. Analysis of variance, two-factor experiment with repeated measures and analysis of covariance were used in comparing the two treatment groups.

FINDINGS

The findings of this study are divided into the following four major categories:

1. Analysis of variance of the mean pre-test scores for the demonstration and control groups to determine the equality of the two groups at the start of the experiment.
2. Analysis of the mean pre-test and post-test scores for the demonstration and control groups by a two-factor experiment using repeated measures.
3. Analysis of covariance of the mean post-test scores for the demonstration and control groups.
4. Correlations between variables related to student achievement and the post-test scores of the individual students.

All analyses have been presented to support the acceptance or rejection of specific null hypotheses. The hypotheses were tested to provide evidence that would satisfy the objectives of the study. Since a different post-test was needed for each of the four subject matter areas and a possibility of interaction between subject matter and method of instruction existed, no attempt was made to combine the four subject matter areas for a composite analysis.

Analysis of Variance

The following analysis of variance model with fixed treatment effects as explained by Snedecor and Cochran (22) was used:

$$Y_{ij} = u + a_i + e_{ij}$$

where

Y_{ij} = class pre-test mean, $i = 1, 2, j = 1, \dots, 6$

u = overall grand mean

a_i = treatment effect, $i = 1$ for demonstrations and 2 for control

e_{ij} = random error

Ho₁ -- There was no difference between the mean pre-test scores for the animal health unit taught to the demonstration and control groups.

Ho₂ -- There was no difference between the mean pre-test scores for the commercial fertilizers unit taught to the demonstration and control groups.

Ho₃ -- There was no difference between the mean pre-test scores for the small gasoline engines unit taught to the demonstration and control groups.

Ho₄ -- There was no difference between the mean pre-test scores for the farm credit unit taught to the demonstration and control groups.

The mean pre-test scores and calculated F values for each of the four subject matter areas are presented in Table 2. Analysis of variance revealed nonsignificant F values for all four subject matter areas indicating that the mean pre-test scores of the two groups were essentially the same. This resulted in the failure to reject the four null hypotheses that there were no differences between the two groups as measured by the mean pre-test scores for the four subject matter areas.

Table 2. Mean pre-test scores and calculated F values by subject matter area for the demonstration and control groups

	Animal health	Commercial fertilizers	Small gasoline engines	Farm credit
Demonstrations	35.09	31.28	40.41	44.25
Control	34.04	33.62	38.42	48.39
Difference	1.05	2.34	1.99	4.14
F value	.13	.69	.24	.63

Analysis of the Two-Factor Experiment

A two-factor experiment with repeated measures was used to analyze the mean pre-test and post-test scores for the demonstration and control schools. The model for this analysis presented by Winer (31) is as follows:

$$Y_{ijk} = u + a_i + s_{ij} + b_k + (ab)_{ik} + e_{ijk}$$

where

Y_{ijk} = class mean pre-test and post-test scores

u = overall grand mean

a_i = effect of treatment, $i = 1$ for demonstrations and 2 for control

s_{ij} = effect of the j^{th} class in the i^{th} treatment, $j = 1, \dots, 6$

b_k = effect of the repeated measure, $k = 1$ for pre-test and 2 for post-test

$(ab)_{ik}$ = interaction of the k^{th} repeated measure within the i^{th} treatment

e_{ijk} = random error

In this analysis, the F test for method was completely confounded with differences between the pre-test and post-test means. The corresponding error variance was large which greatly reduced the chance for significance. However, a different error variance was used in the other two F tests which was not affected by confounding. They are more sensitive tests.

Ho₅ -- There was no difference between the combined animal health mean pre-test and post-test scores for the demonstration and the control groups.

Ho₆ -- There was no difference between the mean animal health pre-test and post-test scores for the demonstration and control groups.

Ho₇ -- There was no difference in the magnitude of change from the mean animal health pre-test scores to the post-test scores for the two groups.

The analysis of the two-factor experiment using the repeated measures of animal health mean pre-test and post-test scores is reported in Table 3. The composite animal health mean pre-test and post-test scores are presented in Table 4. A nonsignificant F value for method resulted in failure to reject the null hypothesis that there was no difference between the combined mean pre-test and post-test scores of the two groups in animal health subject matter.

A highly significant F value of 186.58 was obtained comparing the pre-test and post-test scores. This forced rejection of the null hypothesis that there was no difference between the mean animal health

Table 3. Two-factor experiment analysis using the repeated measures of mean pre-test and post-test scores for the animal health unit

Source of variation	Degrees of freedom	Mean square	F
Method	1	7.61	0.01
Error (a)	10	87.67	
Time	1	2737.28	186.58**
Method x Time	1	28.36	1.93
Error (b)	10	14.67	
Total	23		

** Significant beyond the .01 level.

Table 4. Composite mean pre-test and post-test scores of the demonstration and control groups for the animal health unit

Mean	Pre-test	Post-test	Mean
Demonstrations	35.09	54.27	44.68
Control	34.04	57.57	45.81
Mean	35.56	55.92	

pre-test and post-test scores for the demonstration and control groups. A significant amount of knowledge as measured by the difference between the animal health pre-test and post-test scores was gained by the students during the three-week instructional period.

The F value for the interaction of method and time was not significant. The null hypothesis stating there was no difference in the increase in knowledge for the demonstration and control groups was not rejected.

Ho₈ -- There was no difference between the combined commercial fertilizers mean pre-test and post-test scores for the demonstration and the control groups.

Ho₉ -- There was no difference between the mean commercial fertilizers pre-test and post-test scores for the demonstration and control groups.

Ho₁₀ -- There was no difference in the magnitude of change from the mean commercial fertilizers pre-test scores to the post-test scores for the two groups.

The two-factor experiment analysis for commercial fertilizers subject matter appears in Table 5. Composite mean pre-test and post-test scores for the demonstration and control groups for the commercial fertilizers unit are given in Table 6.

A nonsignificant F value of 1.00 was calculated for the effect of the method which failed to reject the null hypothesis. However, it must be pointed out again that the effect of the method was confounded with the difference between the pre-test and post-test mean scores which resulted in a relatively insensitive test.

Table 5. Two-factor experiment analysis using the repeated measures of mean pre-test and post-test scores for the commercial fertilizers unit

Source of variation	Degrees of freedom	Mean square	F
Method	1	78.23	1.00
Error (a)	10	78.66	
Time	1	1072.40	64.04**
Method x Time	1	9.79	0.58
Error (b)	10	16.75	
Total	23		

** Significant beyond the .01 level.

Table 6. Composite mean pre-test and post-test scores for the demonstration and control groups for the commercial fertilizers unit

Method	Pre-test	Post-test	Mean
Demonstrations	31.28	43.38	37.33
Control	33.62	48.26	40.94
Mean	32.45	45.82	

A highly significant gain was found in the commercial fertilizers unit between the pre-test and post-test scores. The F value of 64.04 rejected the null hypothesis that there was no difference between the combined mean pre-test and post-test scores of the two groups. The F value for the method by time interaction was not significant, resulting in the failure to reject the null hypothesis that no difference existed in the magnitude of change from the pre-test to the post-test for the demonstration and control groups.

Ho₁₁ -- There was no difference between the combined small gasoline engines mean pre-test and post-test scores for the demonstration and control groups.

Ho₁₂ -- There was no difference between the mean small gasoline engines pre-test and post-test scores for the demonstration and control groups.

Ho₁₃ -- There was no difference in the magnitude of change from the mean small gasoline engines pre-test scores to the post-test scores for the two groups.

Table 7 presents the two-factor experiment analysis using the repeated measures of mean pre-test and post-test scores for the small gasoline engines unit. The composite small gasoline engines pre-test and post-test means are given in Table 8.

The two-factor experiment analysis of the small gasoline engines pre-test and post-test scores revealed findings similar to those in the animal health and commercial fertilizers subject matter areas. The null hypothesis that there was no difference between the two groups as

Table 7. Two-factor experiment analysis using the repeated measures of mean pre-test and post-test scores for the small gasoline engines unit

Source of variation	Degrees of freedom	Mean square	F
Method	1	17.07	0.24
Error (a)	10	69.92	
Time	1	4164.86	182.96**
Method x Time	1	80.89	3.55
Error (b)	10	22.76	
Total	23		

** Significant beyond the .01 level.

Table 8. Composite mean pre-test and post-test scores for the demonstration and control groups for the small gasoline engines unit

Method	Pre-test	Post-test	Mean
Demonstrations	40.41	63.08	51.75
Control	38.42	68.44	53.43
Mean	39.42	65.76	

measured by the combined pre-test and post-test scores was not rejected.

A highly significant F value of 182.96 between the combined groups small gasoline engines mean pre-test and post-test scores was obtained. The null hypothesis was rejected.

The F value of 3.55 was not significant for the interaction of method and time. Therefore, the null hypothesis indicating no difference between the increase in knowledge of the demonstration and control groups was not rejected.

Ho₁₄ -- There was no difference between the combined farm credit mean pre-test and post-test scores for the demonstration and control groups.

Ho₁₅ -- There was no difference between the mean farm credit pre-test and post-test scores for the demonstration and control groups.

Ho₁₆ -- There was no difference in the magnitude of change from the mean farm credit pre-test scores to the post-test scores for the two groups.

Analysis of the two-factor experiment using repeated measures for farm credit subject matter is revealed in Table 9. The farm credit composite pre-test and post-test means are tabulated in Table 10.

Inspection of Table 9 reveals that findings in the farm credit unit were consistent with those in the other three subject matter areas. Only the F value of 46.36 for the time was significant. This provided evidence for the rejection of the null hypothesis that no difference existed between the mean farm credit pre-test and post-test scores.

The calculated F values for method and for the interaction of method and time were both found to be nonsignificant. The null hypothesis

Table 9. Two-factor experiment analysis using the repeated measures of mean pre-test and post-test scores for the farm credit unit

Source of variation	Degrees of freedom	Mean square	F
Method	1	123.94	1.42
Error (a)	10	87.24	
Time	1	1469.22	46.36**
Method x Time	1	0.97	0.03
Error (b)	10	31.69	
Total	23		

** Significant beyond the .01 level.

Table 10. Composite mean pre-test and post-test scores for the demonstration and control groups for the farm credit unit

Method	Pre-test	Post-test	Mean
Demonstrations	44.25	59.49	51.87
Control	48.39	64.44	56.42
Mean	46.32	61.97	

that there was no difference between the combined pre-test and post-test scores for the demonstration and control group was not rejected. The null hypothesis that there was no difference between the increase in knowledge attained by students in the demonstration and control groups also failed to be rejected.

Analysis of Covariance

Analysis of covariance was used to compare the mean achievement of the students in the demonstration and control groups. This procedure allowed for the adjustment of initial differences between the two groups with respect to independent variables that were related to the post-test scores. The general model for the analysis of covariance as described by Snedecor and Cochran (22) with two covariates is as follows:

$$Y_{ij} = u + a_i + B_1x_1 + B_2x_2 + e_{ij}$$

where

Y_{ij} = class post-test mean, $i = 1, 2$, $j = 1, \dots, 6$

u = overall grand mean

a_i = treatment effect, $i = 1$ for demonstration and 2 for control

B_1 = partial regression coefficient of Y on X_1

x_1 = the deviation of X_{1ij} from the overall mean of X_1

B_2 = partial regression coefficient of Y on X_2

x_2 = the deviation of X_{2ij} from the overall mean of X_2

e_{ij} = random error

This model was expanded when three covariates were used.

Since class means were the experimental units, the total number of observations was 12 and the number of covariates that could be used in the

model at one time was limited. Analyses indicated that the maximum adjustment of post-test means was obtained with no more than three covariates in the analysis of covariance model.

Ho₁₇ -- There was no difference between the mean animal health post-test scores for the demonstration and control groups when the initial differences between the two groups with respect to pre-test, intelligence quotient and agricultural achievement mean scores had been adjusted.

The mean scores for the pre-test, intelligence quotient and agricultural achievement are presented along with the unadjusted and adjusted mean animal health post-test scores for the demonstration and control groups in Table 11. The unadjusted mean for the control group was observed to be 3.30 points higher than that for the demonstration group. When a single-classification analysis of variance was calculated between the unadjusted means, a nonsignificant F value of .43 was found.

Table 11. Effect of covariates (pre-test, intelligence quotient and agricultural achievement mean scores) on the animal health mean post-test scores

Groups	Covariates			Post-test	
	Pre-test	IQ	Agricultural achievement	Unadjusted	Adjusted
Demonstrations	35.09	99.69	61.74	54.27	53.83
Control	34.04	101.96	57.41	57.57	58.01
Difference	1.05	2.27	4.33	3.30	5.18

Inspection of the covariate means revealed that the demonstration group had higher pre-test and agricultural achievement mean scores, whereas the control group had the higher mean intelligence quotient. When these differences were accounted for, the adjusted mean post-test scores were 58.01 for the control group and 53.83 for the demonstration group. A nonsignificant F value of 3.43 as reported in Table 12 was found when the analysis of covariance was computed using the three covariates mentioned above. This resulted in failure to reject the null hypothesis that there was no difference between the demonstration and control groups when the initial differences between the two groups had been adjusted with respect to pre-test, intelligence quotient and agricultural achievement mean scores.

Table 12. Analysis of covariance for the animal health mean post-test scores for the demonstration and control groups using pre-test, intelligence quotient and agricultural achievement mean scores as covariates

Source of variation	d.f.	Residual S.S.	M.S.	F
Method	1	39.89	39.89	3.43
Error	7	81.41	11.63	
Total	8	121.30		

Ho₁₈ -- There was no difference between the mean animal health post-test scores for the demonstration and control groups when the initial differences between the two groups with respect to Minnesota Teacher

Attitude Inventory score and years of teacher tenure had been adjusted.

The group means for teacher attitude and teacher tenure in Table 13 reveal the demonstration group to have the highest means for both covariates. However, due to a negative correlation between teacher tenure and mean post-test scores, the post-test means were adjusted in favor of the demonstration group.

Table 13. Effect of covariates (Minnesota Teacher Attitude Inventory score and years of teacher tenure) on the animal health mean post-test scores

Groups	Covariates		Post-test	
	Teacher attitude	Teacher tenure	Unadjusted	Adjusted
Demonstrations	65.50	17.33	54.27	57.39
Control	52.67	4.83	57.57	54.44
Difference	12.83	12.50	3.30	2.95

Adjustment of the post-test mean scores for the effects of the covariates resulted in the demonstration group's adjusted mean being 2.95 points higher than the control group mean. The analysis of covariance as presented in Table 14 revealed an F value of .99 which was not significant. The null hypothesis that there was no difference between the demonstration and control groups after being equated for initial differences between the two groups with respect to teacher attitude and years of teacher tenure was not rejected.

Table 14. Analysis of covariance for the animal health mean post-test scores for the demonstration and control groups using Minnesota Teacher Attitude Inventory scores and years of teacher tenure as covariates

Source of variation	d.f.	Residual S.S.	M.S.	F
Method	1	82.99	82.99	.99
Error	8	711.68	88.96	
Total	9	794.67		

Ho₁₉ -- There was no difference between the mean animal health post-test scores for the demonstration and control groups when the initial differences between the two groups with respect to crop acres, animal units and class size had been adjusted.

Inspection of the data in Table 15 verified that the demonstration group means for crop acres and animal units were lower than the means for the control group. The demonstration group had a higher mean class size but a negative correlation ($-.4347$) existed between class size and mean animal health post-test score. Therefore, when initial differences between the two groups were equated, the adjustments were in favor of the demonstration group with respect to all three covariates.

A reduction of the 3.30 difference between the two groups to a difference of only .42 in favor of the control group was achieved when the animal health post-test means were adjusted for the effects of crop acres, animal units and class size. The results of the analysis of

covariance are presented in Table 16. The calculated F value of .16 was not significant, resulting in failure to reject the null hypothesis as stated above.

Table 15. Effect of covariates (crop acres, animal units and class size) on the animal health mean post-test scores

Groups	Covariates			Post-test	
	Crop acres	Animal units	Class size	Unadjusted	Adjusted
Demonstrations	197.31	70.67	16.83	54.27	55.71
Control	228.22	123.99	11.50	57.57	56.13
Difference	30.91	53.32	5.33	3.30	.42

Table 16. Analysis of covariance for the animal health mean post-test scores for the demonstration and control groups using crop acres, animal units and class size as covariates

Source of variation	d.f.	Residual S.S.	M.S.	F
Method	1	13.68	13.68	.16
Error	7	601.44	85.92	
Total	8	615.12		

Ho₂₀ — There was no difference between the mean animal health post-test scores of the demonstration and control groups when the initial differences

between the two groups with respect to verbal reasoning aptitude scores, animal units and department size had been adjusted.

The group means for the verbal reasoning aptitude scores, animal units and department size are presented in Table 17 along with the unadjusted and adjusted animal health post-test means. Inspection of the means show that the control group had an advantage with respect to verbal reasoning aptitude scores and animal units. Although the demonstration group had a larger mean department size than the control group, there was a negative correlation of $-.4126$ between department size and animal health mean post-test score. As a result, the adjustment of the post-test means favored the demonstration group with respect to all three covariates.

Table 17. Effect of covariates (verbal reasoning aptitude, animal units and department size) on the animal health mean post-test scores

Groups	Covariates			Post-test	
	Verbal reasoning	Animal units	Department size	Unadjusted	Adjusted
Demonstrations	48.15	70.67	53.67	54.27	59.15
Control	56.38	123.99	38.67	57.57	52.69
Difference	8.23	53.32	15.00	3.30	6.46

Adjustment of the animal health post-test means resulted in the demonstration group achieving higher than the control group. The adjusted post-test mean for the demonstration group was 59.15 as compared to 52.69

for the control group. This higher mean achievement by the demonstration group was not found to be significant by the analysis of covariance reported in Table 18. The null hypothesis assuming no difference between the mean animal health post-test scores for the two groups when adjusted for initial differences with respect to verbal reasoning aptitude scores, animal units and department size was not rejected.

Table 18. Analysis of covariance for the animal health mean post-test scores for the demonstration and control groups using verbal aptitude, animal units and department size as covariates

Source of variation	d.f.	Residual S.S.	M.S.	F
Method	1	11.62	11.62	1.46
Error	7	55.79	7.97	
Total	8	67.41		

Four separate analysis of covariance tests were made of the difference between the demonstration and control groups as measured by the animal health mean post-test scores using a different combination of covariates for each test. In all four analyses, the null hypotheses stating no differences between the two groups failed to be rejected.

Ho₂₁ -- There was no difference between the mean commercial fertilizers post-test scores for the demonstration and control groups when the initial difference between the two groups with respect to pre-test, intelligence quotient and agricultural achievement mean scores had been adjusted.

The mean pre-test, intelligence quotient, agricultural achievement, and unadjusted and adjusted post-test mean scores for the demonstration and control groups are presented in Table 19. The unadjusted post-test mean was 43.38 for the demonstration group and 48.26 for the control schools. When a single-classification analysis of variance was computed for the difference between the two groups, a calculated F value of 1.00 was found. This was not a significant F value although the control group mean was 4.88 points greater than that for the demonstration group.

Table 19. Effect of covariates (pre-test, intelligence quotient and agricultural achievement mean scores) on the commercial fertilizers mean post-test scores

Groups	Covariates			Post-test	
	Pre-test	IQ	Agricultural achievement	Unadjusted	Adjusted
Demonstrations	31.28	101.35	52.21	43.38	45.74
Control	33.62	104.20	62.14	48.26	45.90
Difference	2.34	4.85	9.93	4.88	.16

Inspection of the pre-test, intelligence quotient and agricultural achievement mean scores revealed that the control group's mean scores were higher than those of the demonstration group for all three areas. When the commercial fertilizers post-test means for the two groups were adjusted for the effects of these covariates, there was virtually no difference between them. The adjusted mean post-test score was 45.74 for the demonstration group and 45.90 for the control group. When analysis of

variance was computed using the above variables as covariates, the calculated F value as shown in Table 20 was reduced to .003. This resulted in failure to reject the null hypothesis that there was no difference between the demonstration and control groups when the initial differences between the two groups with respect to the three covariates had been adjusted.

Table 20. Analysis of covariance for the commercial fertilizers mean post-test scores for the demonstration and control groups using pre-test, intelligence quotient and agricultural achievement mean scores as covariates

Source of variation	d.f.	Residual S.S.	M.S.	F
Method	1	.05	.05	.003
Error	7	124.67	17.81	
Total	8	125.72		

Ho₂₂ -- There was no difference between the mean commercial fertilizers post-test scores for the demonstration and control groups when the initial differences between the two groups with respect to Minnesota Teacher Attitude Inventory scores and years of teacher tenure had been adjusted.

The data presented in Table 21 show the demonstration group means for teacher attitude and years of teacher tenure to be higher than those for the control group. However, a negative correlation of $-.3985$ was found between years of teacher tenure and mean commercial fertilizers post-test score, whereas a positive correlation of only $.0108$ existed between

teacher attitude and mean commercial fertilizers post-test scores, Therefore, the post-test means of the two groups were adjusted in favor of the demonstration group.

Table 21. Effect of covariates (Minnesota Teacher Attitude Inventory score and years of teacher tenure) on the commercial fertilizers mean post-test scores

Groups	Covariates		Post-test	
	Teacher attitude	Teacher tenure	Unadjusted	Adjusted
Demonstrations	65.50	17.33	43.38	47.79
Control	52.67	4.83	48.26	43.85
Difference	12.83	12.50	4.88	3.94

The adjusted means revealed that the demonstration group had a mean post-test score of 47.79 compared to a mean score of only 43.85 for the control group. The difference between the two groups was 3.94 points in favor of the demonstration group. However, this higher mean achievement by the demonstration group was not found to be significant by the analysis of covariance reported in Table 22. The null hypothesis that there was no difference between the mean commercial fertilizers post-test scores of the groups when adjusted for initial differences with respect to teacher attitude score and years of teacher tenure was not rejected.

Ho₂₃ — There was no difference between the mean commercial fertilizers post-test scores for the demonstration and control groups when the initial

differences between the two groups with respect to crop acres, animal units and class size had been adjusted.

Table 22. Analysis of covariance for the commercial fertilizers mean post-test scores for the demonstration and control groups using Minnesota Teacher Attitude Inventory score and years of teacher tenure as covariates

Source of variation	d.f.	Residual S.S.	M.S.	F
Method	1	2.86	2.86	.06
Error	8	637.52	79.69	
Total	9	640.38		

A study of the means in Table 23 confirmed that the means for the demonstration group were lower than the control group means for crop acres and animal units. The demonstration group had a higher mean class size than the control group but a negative correlation ($-.3489$) was found to exist between class size and commercial fertilizers post-test scores. As a result, when initial differences between the two groups were equated, the adjustment was in favor of the demonstration group with respect to all three covariates.

Adjustment of the post-test mean scores for the two groups resulted in the demonstration group having a higher mean score than the control group. The difference between the adjusted mean post-test scores for the two groups was only .83. The analysis of covariance presented in Table 24 revealed a nonsignificant F value of .81. Therefore, the null

hypothesis as stated above was not rejected.

Table 23. Effect of covariates (crop acres, animal units and class size) on the commercial fertilizers mean post-test scores

Groups	Covariates			Post-test	
	Crop acres	Animal units	Class size	Unadjusted	Adjusted
Demonstrations	226.78	100.83	13.50	43.38	46.22
Control	236.98	186.58	8.83	48.26	45.42
Difference	10.20	85.75	4.67	4.88	.80

Table 24. Analysis of covariance for the commercial fertilizers mean post-test scores for the demonstration and control groups using crop acres, animal units and class size as covariates

Source of variation	d.f.	Residual S.S.	M.S.	F
Method	1	37.38	37.38	.81
Error	7	323.33	46.19	
Total	8	360.71		

Ho₂₄ -- There was no difference between the mean commercial fertilizers post-test scores for the demonstration and control groups when the initial differences between the two groups with respect to mean agricultural

achievement scores, crop acres and years of teacher tenure had been adjusted.

The group means for the agricultural achievement scores, crop acres and years of teacher tenure along with the unadjusted and adjusted commercial fertilizers post-test means are presented in Table 25. The covariate means indicate that the control group had an advantage with respect to agricultural achievement scores and crop acres. Although the demonstration group had a larger mean class size than the control group, a negative correlation between class size and commercial fertilizers mean post-test scores resulted in adjustment of the post-test means in favor of the demonstration group with respect to all three covariates.

Table 25. Effect of covariates (agricultural achievement mean scores, crop acres and years of teacher tenure) on the commercial fertilizers mean post-test scores

Groups	Covariates			Post-test	
	Agricultural achievement	Crop acres	Teacher tenure	Unadjusted	Adjusted
Demonstrations	52.21	226.78	17.33	43.38	51.61
Control	62.14	236.98	4.83	48.26	39.93
Difference	9.93	10.20	12.50	4.88	11.68

The largest adjustment of commercial fertilizers post-test means occurred when using mean agricultural achievement scores, crop acres and years of teacher tenure. When the post-test mean scores were adjusted for

the initial differences between the two groups with respect to these three covariates, the demonstration group's mean post-test score was 11.68 points higher than the mean post-test score for the control group. Nevertheless, the analysis of covariance set forth in Table 26 resulted in a nonsignificant F value of 2.27. The null hypothesis stating there was no difference between the mean commercial fertilizers post-test scores of the two groups when adjusted for initial differences with respect to mean agricultural achievement scores, crop acres and years of teacher tenure was not rejected.

Table 26. Analysis of covariance for the commercial fertilizers mean post-test scores for the demonstration and control groups using agricultural achievement mean scores, crop acres and years of teacher tenure as covariates

Source of variation	d.f.	Residual S.S.	M.S.	F
Method	1	60.07	60.07	2.27
Error	7	185.36	26.48	
Total	8	245.43		

Four null hypothesis were tested by analysis of covariance to determine if there was a difference between the achievement of the students in the demonstration and control groups as measured by the commercial fertilizers post-test scores. A different combination of covariates was used for each covariance test. All four of the null hypotheses failed to be rejected.

Ho₂₅ -- There was no difference between the mean small gasoline engines post-test scores for the demonstration and control groups when the initial differences between the two groups with respect to mean pre-test, intelligence quotient and agricultural achievement scores had been adjusted.

The data appearing in Table 27 show the demonstration group mean for the small gasoline engines pre-test to be higher than that for the control group. The control group means were higher for the intelligence quotient and agricultural achievement mean scores. The unadjusted mean post-test score was 63.08 for the demonstration group and 68.44 for the control group. A single-classification analysis of variance was computed on the unadjusted mean post-test scores of the two groups. A nonsignificant F value of 1.98 was calculated.

Table 27. Effect of covariates (pre-test, intelligence quotient and agricultural achievement mean scores) on the small gasoline engines mean post-test scores

Groups	Covariates			Post-test	
	Pre-test	IQ	Agricultural achievement	Unadjusted	Adjusted
Demonstrations	40.41	101.28	57.71	63.08	64.23
Control	38.42	104.73	61.26	68.44	67.29
Difference	1.99	3.45	3.55	5.36	3.06

Since the demonstration group was lower on two of the variables and the control group on the other, there was only a small adjustment in favor of the demonstration group on the post-test means. This adjustment tended to equate the groups by reducing the difference between the two groups to only 3.06. The analysis of covariance presented in Table 28 reduced the F value to .60 when taking into account the effects of the mean pre-test, intelligence quotient and agricultural achievement scores. This resulted in failure to reject the null hypothesis implying no difference between the two groups when initial differences between the groups with respect to the three covariates had been adjusted.

Table 28. Analysis of covariance for the small gasoline engines mean post-test scores for the demonstration and control groups using pre-test, intelligence quotient and agricultural achievement mean scores as covariates

Source of variation	d.f.	Residual	M.S.	F
		S.S.		
Method	1	15.09	15.09	.60
Error	7	174.86	24.98	
Total	8	189.95		

Ho₂₆ -- There was no difference between the mean small gasoline engines post-test scores for the demonstration and control groups when the initial differences between the two groups with respect to Minnesota Teacher Attitude Inventory score and years of teacher tenure had been adjusted.

The mean Minnesota Teacher Attitude Inventory scores and mean years of teacher tenure, and unadjusted and adjusted small gasoline engines post-test mean scores for the demonstration and control groups are presented in Table 29. Examination of the means indicate the demonstration group had higher scores for both covariates. However, both covariates were negatively correlated with the mean small gasoline engines post-test scores resulting in an adjustment of the post-test scores in favor of the demonstration group.

Table 29. Effect of covariates (Minnesota Teacher Attitude Inventory score and years of teacher tenure) on the small gasoline engines mean post-test scores

Groups	Covariates		Post-test	
	Teacher attitude	Teacher tenure	Unadjusted	Adjusted
Demonstrations	65.50	17.33	63.08	63.94
Control	52.67	4.83	68.44	67.58
Difference	12.83	12.50	5.36	3.64

The difference between the adjusted small gasoline engines post-test mean scores was 3.64 as compared to a 5.36 difference between the unadjusted post-test mean scores of the demonstration and control groups. The analysis of covariance presented in Table 30 revealed a nonsignificant F value of .33. The null hypothesis that there was no difference between the demonstration and control groups when equated with respect to the covariates was not rejected.

Table 30. Analysis of covariance for the small gasoline engines mean post-test scores for the demonstration and control groups using Minnesota Teacher Attitude Inventory scores and years of teacher tenure as covariates

Source of variation	d.f.	Residual S.S.	M.S.	F
Method	1	17.56	17.65	.33
Error	8	430.72	53.84	
Total	9	448.37		

Ho₂₇ -- There was no difference between the mean small gasoline engines post-test scores for the demonstration and control groups when the initial differences between the two groups with respect to mean abstract reasoning aptitude scores, verbal reasoning aptitude scores and class size had been adjusted.

The group means for the three covariates are shown in Table 31 with the unadjusted and adjusted post-test mean scores. Inspection of the data reveal that the control group means are higher for the abstract reasoning aptitude and verbal reasoning aptitude scores. The demonstration group had a higher mean class size but a negative correlation of $-.3326$ was found to exist between class size and the small gasoline engines mean post-test scores. This resulted in an adjustment of the mean post-test scores in favor of the demonstration group with respect to all three covariates.

Table 31. Effect of covariates (abstract reasoning aptitude, verbal reasoning aptitude and class size) on the small gasoline engines mean post-test scores

Groups	Covariates			Post-test	
	Abstract reasoning	Verbal reasoning	Class size	Unadjusted	Adjusted
Demonstrations	53.99	49.02	14.00	63.08	63.73
Control	60.85	52.61	9.67	68.44	67.79
Difference	6.86	3.59	4.33	5.36	4.06

The adjusted post-test mean scores were 67.79 for the control group and 63.73 for the demonstration group. The difference of 4.06 between the adjusted post-test scores was not found to be significant by the analysis of covariance presented in Table 32. The null hypothesis that there was no difference between the mean post-test scores of the demonstration and control groups when the initial difference between the two groups with respect to the three covariates had been adjusted was not rejected.

Ho₂₈ -- There was no difference between the mean small gasoline engines post-test scores for the demonstration and control groups when the initial differences between the two groups with respect to agricultural achievement mean scores, animal units and department size had been adjusted.

Table 32. Analysis of covariance for the small gasoline engines mean post-test scores for the demonstration and control groups using abstract reasoning aptitude, verbal reasoning aptitude and class size as covariates

Source of variation	d.f.	Residual S.S.	M.S.	F
Method	1	46.19	46.19	1.76
Error	7	183.96	26.28	
Total	8	230.15		

Examination of the data in Table 33 disclosed that the control group had higher mean scores for the agricultural achievement and animal unit variables. The demonstration group had a higher mean department size than the control group. A negative correlation was found between department size and small gasoline engines mean post-test scores. Hence, the demonstration group was at a disadvantage with respect to all three covariates.

Adjustment of the small gasoline engines post-test means for initial differences with respect to mean agricultural achievement scores, animal units and department size resulted in a difference of only .02 between the demonstration and control groups. The adjusted post-test means were 65.77 for the demonstration group and 65.75 for the control group. The analysis of covariance presented in Table 34 derived a nonsignificant F value of .54. This resulted in failure to reject the null hypothesis as stated above.

In the four analysis of covariance tests that were made on the small gasoline engines post-test scores, the covariates were found to have only

a small effect on the adjustment of the mean post-test scores. In all four analyses, the respective null hypothesis stating no difference between the two groups was not rejected.

Table 33. Effect of covariates (agricultural achievement mean scores, animal units and department size) on the small gasoline engines mean post-test scores

Groups	Covariates			Post-test	
	Agricultural achievement	Animal units	Department size	Unadjusted	Adjusted
Demonstrations	57.71	68.67	53.67	63.08	65.77
Control	61.26	249.93	38.67	68.44	65.75
Difference	3.55	181.26	15.00	5.36	.02

Table 34. Analysis of covariance for the small gasoline engines mean post-test scores for the demonstration and control groups using agricultural achievement mean scores, animal units and department size as covariates

Source of variation	d.f.	Residual S.S.	M.S.	F
Method	1	13.56	13.56	.54
Error	7	175.07	25.01	
Total	8	188.63		

Ho₂₉ -- There was no difference between the mean farm credit post-test scores for the demonstration and control groups when the initial differences between the two groups with respect to mean pre-test, intelligence quotient and agricultural achievement scores had been adjusted.

The group means for the independent variables used as covariates are presented in Table 35 with the unadjusted and adjusted farm credit post-test mean scores. Single-classification analysis of variance was computed on the difference between the unadjusted farm credit post-test mean scores for the two groups and a nonsignificant F value of 1.95 was obtained. Inspection of the covariate means reveal that the control group had higher mean scores for the pre-test and intelligence quotient variables. The demonstration group had the higher mean for the agricultural achievement scores. Consequently, the adjustment of the post-test means with respect to the pre-test and intelligence quotient was in favor of the demonstration group. Adjustment of the mean post-test scores with respect to the agricultural achievement scores was in favor of the control group.

There was a difference of 3.32 in favor of the control group after the farm credit post-test mean scores for the two groups had been adjusted. This difference was found to be nonsignificant by the analysis of covariance displayed in Table 36. The calculated F value was 2.73. The null hypothesis assuming no difference between the two groups after initial differences were adjusted with respect to the covariates was not rejected.

Table 35. Effect of covariates (pre-test, intelligence quotient and agricultural achievement mean scores) on the farm credit mean post-test scores

Groups	Covariates			Post-test	
	Pre-test	IQ	Agricultural achievement	Unadjusted	Adjusted
Demonstrations	44.25	101.98	72.06	59.50	60.31
Control	48.39	104.77	69.36	64.44	63.63
Difference	4.14	2.79	2.70	4.94	3.32

Table 36. Analysis of covariance for the farm credit mean post-test scores for the demonstration and control groups using pre-test, intelligence quotient and agricultural achievement mean scores as covariates

Source of variation	d.f.	Residual S.S.	M.S.	F
Method	1	72.73	72.73	2.73
Error	7	186.41	26.63	
Total	8	259.14		

Ho₃₀ -- There was no difference between the mean farm credit post-test scores for the demonstration and control groups when the initial differences between the two groups with respect to Minnesota Teacher Inventory scores and years of teacher tenure had been adjusted.

The data presented in Table 37 reveal that the demonstration group had higher mean scores for teacher attitude and years of teacher tenure. However, both teacher attitude and years of teacher tenure were found to be negatively correlated with the farm credit mean post-test scores. Hence, when the post-test mean scores were adjusted with respect to the covariates, the adjustment was in favor of the demonstration group.

Table 37. Effect of covariates (Minnesota Teacher Attitude Inventory score and years of teacher tenure) on the farm credit mean post-test scores

Groups	Covariates		Post-test	
	Teacher attitude	Teacher tenure	Unadjusted	Adjusted
Demonstrations	65.50	17.33	59.50	64.07
Control	52.67	4.83	64.44	59.87
Difference	12.83	12.50	4.94	4.20

The adjusted mean farm credit post-test score for the demonstration group was 64.07 as compared to 59.87 for the control group. The analysis of covariance shown in Table 38 revealed an F value of 4.79 which approached significance. An F value of 5.32 was required for significance at the .05 level. Consequently, the null hypothesis that there was no difference between the mean farm credit post-test scores of the demonstration and control groups when the initial differences between the two groups had been equated with respect to the covariates was not rejected.

Table 38. Analysis of covariance for the farm credit mean post-test scores for the demonstration and control groups using Minnesota Teacher Attitude Inventory scores and years of teacher tenure as covariates

Source of variation	d.f.	Residual S.S.	M.S.	F
Method	1	162.84	162.84	4.79
Error	8	271.68	33.96	
Total	9	434.52		

Ho₃₁ -- There was no difference between the mean farm credit post-test scores for the demonstration and control groups when the differences between the two groups with respect to artistic interest and mechanical interest mean scores had been adjusted.

The mean artistic interest and mechanical interest scores, and the unadjusted and adjusted mean post-test scores for the demonstration and control groups are given in Table 39. The demonstration group had a higher mean score for artistic interest whereas the control group had a higher mean score for mechanical interest. The mean artistic interest scores were found to be negatively correlated ($-.6727$) with the mean post-test scores, whereas the mechanical interest mean scores were found to be positively correlated with the mean post-test scores. Therefore, the adjustment was in favor of the demonstration group when the farm credit post-test scores were adjusted for the effects of the two covariates.

Table 39. Effect of covariates (artistic interest and mechanical interest mean scores) on the farm credit post-test mean scores

Groups	Covariates		Post-test	
	Artistic interest	Mechanical interest	Unadjusted	Adjusted
Demonstrations	47.52	52.42	59.50	62.66
Control	42.11	65.08	64.44	61.78
Difference	5.41	12.66	4.94	.88

Adjustment of the post-test scores resulted in a difference of only .88 between the two groups. The post-test means were 62.66 for the demonstration group and 61.78 for the control group. The F value of .01 derived from the analysis of covariance in Table 40 was not significant. The null hypothesis as stated above was not rejected.

Table 40. Analysis of covariance for the mean farm credit post-test scores for the demonstration and control groups using artistic interest and mechanical interest mean scores as covariates

Source of variation	d.f.	Residual S.S.	M.S.	F
Method	1	.29	.29	.01
Error	8	157.20	19.65	
Total	9	157.49		

Ho₃₂ -- There was no difference between the mean farm credit post-test scores for the demonstration and control groups when the difference between the two groups with respect to mean mechanical interest scores, crop acres and department size had been adjusted.

Examination of the data in Table 41 revealed that the control group had higher mean scores for the mechanical interest and crop acres. The demonstration group had a higher mean department size. Department size was found to be negatively correlated (-.6747) with the mean farm credit post-test scores resulting in an adjustment in favor of the demonstration group with respect to all three covariates.

Table 41. Effect of covariates (mechanical interest, crop acres and department size) on the farm credit post-test mean scores

Groups	Covariates			Post-test	
	Mechanical interest	Crop acres	Department size	Unadjusted	Adjusted
Demonstrations	52.42	188.65	53.67	59.50	63.67
Control	65.08	254.98	38.67	64.44	60.26
Difference	12.66	66.33	15.00	4.94	3.41

The adjusted means were 63.67 for the demonstration group and 60.26 for the control group. The analysis of covariance F value of 1.22 presented in Table 42 was not significant. The null hypothesis implying no difference between the two groups after adjusting for initial differences with respect to the covariates failed to be rejected.

Table 42. Analysis of covariance for the mean farm credit post-test scores for the demonstration and control groups using mechanical interest, crop acres and department size as covariates

Source of variation	d.f.	Residual S.S.	M.S.	F
Method	1	17.79	17.79	1.22
Error	7	102.20	14.60	
Total	8	119.99		

Four null hypotheses were tested by analysis of covariance to determine if there was a difference between the achievement of the students in the demonstration and control groups as measured by the farm credit post-test scores. A different combination of covariates was used for each of the analysis of covariance tests. Nonsignificant F values for each of the tests resulted in failure to reject all four null hypotheses.

Correlation Analyses

A secondary purpose of this study was to determine what factors were related to student achievement when taught each of the four subject matter areas using demonstrations. Correlation coefficients were calculated between related variables and the individual student post-test scores for each of the groups for each of the subject matter areas.

Data presented in Table 43 reveal the correlation coefficients between selected variables and the post-test scores of those students

Table 43. Product-moment correlations of selected variables with the individual student animal health post-test scores for the demonstration and control groups

Variable	Demonstration group	Control group
Pre-test	.8735	.9072
Kuder - Outdoor interest	.8620	.8687
Number of siblings	-.8540	-.8047
DAT - Mechanical reasoning aptitude	.8417	.8161
Kuder - Social service interest	.8083	.7188
Agricultural achievement	.7860	.6180
Kuder - Mechanical interest	.7820	.7995
Kuder - Artistic interest	.7660	.6339
Kuder - Clerical interest	.7381	.7170
Kuder - Literary interest	.7231	.7003
Kuder - Scientific interest	.7150	.6950
Kuder - Computational interest	.6903	.8130
DAT - Verbal reasoning aptitude	.6845	.6052
Kuder - Persuasive interest	.6839	.7395
DAT - Abstract reasoning aptitude	.6786	.6070
Total farm acres	.5941	.6940
Crop acres	.5395	.6835
Intelligence quotient	.5263	.7463
Animal units	.5021	.5365

taught the animal health unit. All of the r values were found to be significant at the .01 level,

Coefficients of correlation with positive r values of .8000 or above were observed in the demonstration group between the animal health post-test and pre-test (.8735), and outdoor interest (.8620), and mechanical reasoning aptitude (.8417) and social service interest (.8083). A negative r value was observed between the animal health post-test and number of siblings (-.8540) for the students taught with demonstrations.

Positive correlations above .8000 were also observed between the animal health post-test and pre-test (.9072), and outdoor interest (.8687), and mechanical reasoning aptitude (.8161) and computational interest (.8130) for the students in the control group. A negative correlation was also found to exist between the control group post-test scores and number of siblings (-.8047).

Correlation coefficients for the commercial fertilizers subject matter area are presented in Table 44. All of the correlation coefficients presented were found to be significant beyond the .01 level as were all the r values for the animal health unit.

A positive coefficient of correlation r value of .8840 was observed between the commercial fertilizers pre-test and post-test. Similar high r values were observed between post-test and clerical interest (.8043), and outdoor interest (.8037) for the students taught by demonstrations.

Positive r values were found to exist between the commercial fertilizers post-test scores and pre-test scores (.8050), and outdoor interest (.8548) and mechanical interest (.8763) for the students in the control group. The control group also had high positive r values when

Table 44. Product-moment correlations of selected variables with the individual student commercial fertilizers post-test scores for the demonstration and control groups

Variable	Demonstration group	Control group
Pre-test	.8840	.8050
Kuder - Clerical interest	.8043	.5950
Kuder - Outdoor interest	.8037	.8548
Kuder - Mechanical interest	.7878	.8763
Number of siblings	-.7714	-.8089
Kuder - Computational interest	.7711	.6073
Kuder - Persuasive interest	.7449	.5144
DAT - Mechanical reasoning aptitude	.7324	.8568
Intelligence quotient	.7217	.6629
DAT - Verbal reasoning aptitude	.7179	.6040
Agricultural achievement	.6672	.6001
Kuder - Artistic interest	.6519	.8340
DAT - Abstract reasoning aptitude	.6404	.7152
Kuder - Social service interest	.6026	.6010
Kuder - Literary interest	.5898	.6515
Kuder - Scientific interest	.5891	.8226
Total farm acres	.5684	.6615
Crop acres	.5497	.6634
Animal units	.4784	.4161

the post-test and mechanical reasoning aptitude (.8568), and artistic interest (.8340) and scientific interest (.8226) scores were compared.

Number of siblings was found to be negatively correlated with the student's post-test scores for the commercial fertilizers unit in both the demonstration and control groups. The negative r value was $-.7714$ for the demonstration group and $-.8089$ for the control group.

Correlation coefficients between selected variables and the small gasoline engines post-test scores for the demonstration and control groups are revealed in Table 45. In the demonstration group, positive r values of greater than .8000 were found between the pre-test and post-test (.9303); between the post-test and outdoor interest (.9105); and between mechanical interest (.8678) and mechanical reasoning aptitude (.8466). A high coefficient of correlation was also observed between the small gasoline engines post-test and social service interest (.8181) for the students taught with demonstrations.

Several variables were found to be correlated highly with the small gasoline engines post-test scores in the control group. Those variables with r values greater than .8000 are: pre-test (.8706), outdoor interest (.8930), mechanical interest (.8486), clerical interest (.8246), artistic interest (.8185) and computational interest (.8154).

As in the animal health and commercial fertilizers units, number of siblings was found to be negatively correlated with the small gasoline engines post-test scores. The negative r values between the number of siblings and post-test scores are $-.8946$ for the demonstration and $-.9352$ for the control group. All correlations presented were found to be significant beyond the .01 level except for the r values for the

Table 45. Product-moment correlations of selected variables with the individual student small gasoline engines post-test scores for the demonstration and control groups

Variable	Demonstration group	Control group
Pre-test	.9303	.8706
Kuder - Outdoor interest	.9105	.8930
Number of siblings	-.8946	-.9352
Kuder - Mechanical interest	.8678	.8486
DAT - Mechanical reasoning aptitude	.8466	.7973
Kuder - Social service interest	.8181	.7139
Kuder - Persuasive interest	.7906	.7066
Kuder - Scientific interest	.7599	.6203
Kuder - Clerical interest	.7582	.8246
Kuder - Artistic interest	.7568	.8185
Kuder - Computational interest	.7448	.8154
Kuder - Literary interest	.7328	.6819
Agricultural achievement	.6336	.5520
Total farm acres	.5865	.7490
Crop acres	.5539	.7516
DAT - Verbal reasoning aptitude	.4749	.5213
Animal units	.4552	.5201
DAT - Abstract reasoning aptitude	.4091	.5711
Intelligence quotient	.2023	-.0699

intelligence quotient. The intelligence quotient correlation coefficients were not significant.

All of the coefficients of correlation presented in Table 46 were found to be significant beyond the .01 level as were the calculated r values for the three subject matter areas already discussed. The following variables had r values greater than .8000 when compared with the farm credit post-test scores in the demonstration group: outdoor interest (.9296), agricultural achievement (.8847), pre-test (.8660), computational interest (.8640), and mechanical interest (.8459). A negative r value of $-.8401$ was obtained between the farm credit post-test and number of siblings in the demonstration group.

Three variables were found to have r values greater than .9000 with the farm credit post-test scores in the control group. These variables were: pre-test (.9426), outdoor interest (.9125), and agricultural achievement (.9058). Other variables in the control group that had high correlations when compared with the farm credit post-test scores were mechanical interest (.8571), computational interest (.8256), clerical interest (.8219), and social science interest (.8232). A negative correlation was also found in the control group between the farm credit post-test score and number of siblings ($-.8870$).

Intelligence quotient was found to be negatively correlated with the achievement of individual students as measured by the farm credit post-test in both groups. The negative r values for the intelligence quotient were $-.4343$ for the demonstration group and $-.4779$ for the control group. These negative coefficients of correlation when comparing

Table 46. Product-moment correlations of selected variables with the individual student farm credit post-test scores for the demonstration and control groups

Variable	Demonstration group	Control group
Kuder - Outdoor interest	.9296	.9125
Agricultural achievement	.8847	.9058
Pre-test	.8660	.9426
Kuder - Computational interest	.8640	.8256
Kuder - Mechanical interest	.8459	.8571
Number of siblings	-.8401	-.8870
Kuder - Clerical interest	.7985	.8219
DAT - Mechanical reasoning aptitude	.7835	.7896
Total farm acres	.7652	.3633
DAT - Verbal reasoning aptitude	.7470	.7530
Kuder - Artistic interest	.7386	.6773
Kuder - Scientific interest	.7284	.6893
Crop acres	.6995	.3578
Kuder - Social science interest	.6818	.8232
DAT - Abstract reasoning aptitude	.6467	.7119
Kuder - Persuasive interest	.6490	.7630
Kuder - Literary interest	.4435	.6762
Intelligence quotient	-.4343	-.4779
Animal units	.4132	.3886

intelligence quotient with post-test scores in the farm credit unit are in contrast with the positive r values found when intelligence quotient was compared to the animal health and commercial fertilizers post-test scores.

DISCUSSION

The expressed purpose of this study was to evaluate the effectiveness of demonstrations as an instructional technique in the teaching of vocational agriculture. This was done by comparing instruction using demonstrations with instruction without the use of demonstrations on the same subject matter units in vocational agriculture. A secondary purpose was to determine the relationship of selected variables to student achievement in vocational agriculture when taught using demonstrations as an instructional technique.

The first analyses were made to compare the mean pre-test scores of the demonstration and control groups for each of the four subject matter areas. Analysis of variance disclosed that the mean pre-test scores of the two groups were not significantly different. These findings supported the assumption that randomization had been successful in equating the demonstration and control groups with respect to prior knowledge of the subject matter that was to be taught. Careful examination of the mean pre-test scores revealed that the control group had higher pre-test means for the commercial fertilizers and farm credit pre-tests. The mean scores for the demonstration treatment group were higher for the animal health and small gasoline engines pre-tests. However, none of these differences were large enough to be significant.

The analysis of the two-factor experiment with the repeated measures of pre-test and post-test scores provided a test for determining if there was a gain in knowledge over the three-week experimental period. Highly significant gains in knowledge were found in all four of the subject

matter areas. This implied that the instructional methods used in both groups were effective teaching methods,

The two-factor experiment analysis also provided a test which determined if the magnitude of change in knowledge from the pre-test to the post-test was different for the demonstration and control groups. The results revealed that there was no significant difference in the amount of knowledge gained by the two groups in any of the four subject matter areas. The control group mean post-test scores were 57.57 for animal health, 48.26 for commercial fertilizers, 68.44 for small gasoline engines and 64.44 for farm credit. The mean scores for the same respective units in the demonstration group were 54.27, 43.38, 63.08 and 59.49.

Inspection of the variation between the mean post-test scores of schools revealed larger differences between schools within groups than between groups. This observation questioned whether randomization had been successful in equating the two groups with respect to all possible factors related to student achievement. The two-factor experiment analysis with repeated measures did not take into account differences between the two groups with respect to student ability, aptitude, interests, and socio-economic background. Neither did the analysis take into account differences due to instructors or schools.

A study conducted by Beane (1) indicated that student achievement was related to the instructor's knowledge of the subject matter. A companion study by Tindall (25) pointed out that there could be a relationship between student achievement and class size, and department size. Tindall also felt that the instructor's tenure might have an effect on student achievement.

Since the two-factor experiment analysis only accounted for the difference between the two groups due to student's prior knowledge of the subject matter, analysis of covariance was used in an attempt to equate for differences with respect to identified variables found to be related to student achievement. Careful examination of the independent variables revealed that different variables were influencing the post-test scores in each of the four subject matter areas. For most of the dependent variables identified and measured, the control group was found to have an advantage.

Because schools were randomized and not students, class means became the experimental units. This resulted in only 12 total observations for the two groups. As a result, the number of covariates that could be included in the analysis of covariance model at one time was quite limited. It was found that the maximum effect as measured by the magnitude of the calculated F values was achieved when only two or three covariates were used at one time.

The independent variables were grouped according to the major characteristics they attempted to measure. Analysis of covariance tests were then computed using combinations of variables that attempted to equate the two groups with respect to student ability, student interests, student aptitudes, student socio-economic background, the effect of the teacher and differences between schools.

In the classes taught the animal health unit, the covariance analysis which accounted for initial differences in student ability and then adjusted post-test scores accordingly, increased the difference between the mean post-test scores of the two groups. The unadjusted post-test

mean for the control was 3.30 higher than the demonstration group, whereas the adjusted mean for the control group was 5.18 higher than that for the demonstration group. However, all other covariance analyses made on the animal health post-test scores resulted in adjustments in favor of the demonstration group.

An attempt was made to measure the effect of the teacher on student achievement by use of the Minnesota Teacher Attitude Inventory and years of teacher tenure in the present schools. Use of these measures as covariates adjusted the demonstration group's animal health post-test mean 2.95 points above the control group mean. This difference was not statistically significant. When initial differences between the two groups with respect to crop acres, animal units and class size were adjusted, the demonstration group animal health post-test mean was raised to 55.71. This was only .42 less than the animal health post-test mean for the control group.

The greatest adjustment of animal health post-test means resulted when verbal reasoning aptitude, animal units and department size were used as covariates. Using these three covariates, the adjusted mean of the demonstration group was 6.46 points higher than that of the control group. However, the analysis of covariance test derived a nonsignificant F value for this difference.

The pre-test, intelligence quotient and agricultural achievement mean scores were used to account for initial differences in student ability in a covariance analysis of the commercial fertilizers mean post-test for the two groups. Adjustment of the commercial fertilizers

post-test means resulted in a difference of only .16 between the demonstration and control groups.

The combinations of covariates used in the other three covariance analyses for the commercial fertilizers post-test scores, all adjusted the demonstration group's post-test mean higher than the control group mean. The greatest adjustment of commercial fertilizers post-test means was accomplished using mean agricultural achievement scores, crop acres and years of teacher tenure. The demonstration group adjusted mean was 51.61 as compared to 39.93 for the control group when these three covariates were used. The computed F value of 2.27 was not significant at the .05 level, however, it was significant at the .25 level of confidence.

None of the analysis of covariance tests of the difference between the mean commercial fertilizers post-test scores for the demonstration and control groups revealed a significant difference at the .05 level of confidence. However, in all four analyses the adjustment of the post-test means was in favor of the demonstration group and in three of the analyses, the adjusted means resulted in the demonstration group being higher than the control group. A possible explanation for the lack of significance could be attributed to the large amount of variance between schools within groups which resulted in an inflated error term for the F tests. None of the independent variables identified and used as covariates were able to account for the large variation between schools.

In the classes taught the small gasoline engines unit, the effect of the covariates used was small. Three of the covariance tests resulted in only negligible adjustments of the small gasoline engines post-test

scores. These same variables had accounted for an appreciable adjustment of the animal health and commercial fertilizers mean post-test scores. This lack of consistency in the effect of these covariates on all three subject matter areas would tend to support the implication that an interaction might exist between these variables and subject matter taught, and/or an interaction of method of instruction and subject matter. The actual testing of such interactions was beyond the scope of this study.

The combination of mean agricultural achievement scores, animal units, and department size were the only covariates that had a notable effect on the adjustment of the small gasoline engines mean post-test scores. Analysis of covariance using these three covariates resulted in adjusted post-test means of 65.77 for the demonstration group and 65.75 for the control group. Since all four of the analysis of covariance tests computed on the small gasoline engines mean post-test scores resulted in nonsignificant difference, the conclusion was drawn that vocational agriculture students taught with demonstrations achieved as well as students taught in the traditional manner.

A tenable explanation for the failure of the students in the demonstration group to achieve higher than those students in the control group is that demonstrations have been used most effectively in farm mechanics instruction in vocational agriculture. Although the instructors in the control group were not to use demonstrations in their teaching, they were familiar with demonstrations and had used them successfully in teaching farm mechanics, therefore, there may have been a tendency by the instructors to organize their instruction of small gasoline engines around the demonstration approach. The result being that for the small gasoline

engines subject matter the instructional approaches used in the control group were very similar to the demonstration approach.

The results of the analysis of covariance tests computed on the farm credit mean post-test scores for the two groups were not significant at the .05 level of confidence, however, in all four analyses, adjustments of the mean post-test scores were in favor of the demonstration group. Three of the covariance analyses adjusted the demonstration group's farm credit post-test mean above that for the control group.

When the initial differences between the mean farm credit post-test scores for the demonstration and control groups with respect to the Minnesota Teacher Attitude Inventory scores and years of teacher tenure were adjusted, the demonstration group mean was the highest. The adjusted post-test mean for the control group was 59.87 as compared to 64.07 for the demonstration group. Analysis of covariance revealed an F value of 4.79 when these two covariates were used. This was not significant at the generally accepted .05 level of confidence. However, the F value of 4.79 was significant beyond the .10 level of confidence.

By accepting the .10 level of confidence, the null hypothesis that there was no difference between the mean farm credit post-test scores for the demonstration and control groups when the initial differences between the group with respect to teacher attitude and tenure had been adjusted would be rejected. The 4.20 difference between the adjusted post-test means of the two groups would indicate that the students in the demonstration group had achieved appreciably higher than the students in the control group.

Further comment should be made about the level of significance that

should be used in rejecting null hypotheses. It has been conventional in behavioral science research to use the .05 and .01 levels of significance. These are the levels usually reported in research literature. However, a lower confidence level may well be justified when evaluating instructional methods and techniques that do not require large sums of money to be spent on new educational equipment. The demonstration is such a method as it conserves the teacher's time, student's time, and materials and equipment. Therefore, the .05 level of confidence should not be necessary for considering the use of the demonstration method.

A secondary purpose of the study was to determine the factors related to student achievement in vocational agriculture when demonstrations were used as an instructional technique. Product-moment correlation coefficients revealed that in general, the characteristics of the individual students who performed best on the post-test of each subject matter unit were similar for the demonstration and control groups. The same types of students who achieved well when taught with demonstrations did well when taught without the use of demonstrations. However, different student characteristics were found to be highly related to student achievement in each of the four subject matter areas.

For animal health, a total of 19 variables were identified and found significantly correlated with the post-test. Of these, the animal health pre-test and outdoor interest scores were found to be the highest correlating variables for both the demonstration and control groups. Negative correlations were observed between the number of siblings and animal health post-test scores. This implied that students with fewer brothers and sisters tended to achieve higher on the post-test. It was

further observed that all areas of the Kuder interest inventory were positively related to student animal health post-test scores, as were the three sections of the Differential Aptitude Tests that were administered.

Interesting relationships were observed between the post-tests for all four subject matter areas and the number of crop acres, and the number of animal units for the students' home farms. Significant correlations between both of these variables and the post-test scores for all subject matter areas provided support for the implication that students from larger farms tend to do better in vocational agriculture.

All 19 variables were again found to be significantly correlated with the commercial fertilizers post-test scores. The highest correlating variable for the demonstration group was the pre-test, whereas mechanical interest was the highest in the control group. The relationship of most of the variables to the commercial fertilizers post-test scores were similar for both the demonstration and control groups.

For the students taught small gasoline engines, the pre-test, outdoor interest and mechanical interest scores were observed to have the highest positive coefficients of correlation with the post-test scores. All r values for the small gasoline engines unit were significant except for the one for the intelligence quotient score. The lack of a significant relationship between intelligence quotient and post-test scores may have been due to the high interest of the students in small gasoline engines. The small gasoline engines unit is generally taught to vocational agriculture students in the eleventh grade. Students at this age are generally quite interested in engines and mechanics. This interest may have been more important than student ability as measured by the

intelligence quotient score in predicting student achievement on the small gasoline engines post-test.

The r values for all 19 variables were again significant in farm credit. The highest correlation coefficients were for outdoor interest, agricultural achievement and pre-test scores. The relationship of the variables to the farm credit post-test scores were similar for the two groups. The correlation coefficients for the variables were similar to those in the other subject matter areas with the exception of the intelligence quotient scores. Intelligence quotient scores were found to be negatively correlated with the farm credit post-test for both the demonstration and control groups. This negative relationship of intelligence quotient with the post-test was contrary to the findings in the animal health and commercial fertilizers units. This was also in contrast with most research findings that brighter students generally achieve higher than students of lower intelligence.

A possible explanation might be that twelfth grade students in vocational agriculture have fairly strong occupational and educational goals that affect their achievement in the farm credit unit. This is further substantiated by the high correlation coefficients between the farm credit post-test scores and (1) the Kuder interest scores, and (2) the agricultural achievement scores. Students who had definite interests and abilities in agriculture might have been the students who achieved highest regardless of their intelligence quotient scores. Unfortunately it was beyond the limitations and scope of this study to determine the relationship of students' educational and occupational goals to student achievement.

All analyses conducted which compared the achievements of students on the post-tests in the demonstration and control groups resulted in nonsignificant differences between the two groups. However, for each of the four subject matter areas analysis of covariance resulted in the adjusted post-test means for the demonstration group being higher than those for the control group.

In addition, had the .10 level of significance been accepted, the students taught farm credit in the demonstration group would have had an appreciably greater achievement than the students in the control group. Use of the .25 level of confidence would have resulted in a significant difference between the commercial fertilizers post-test scores in favor of the demonstration groups.

Since the four units were representative of the vocational agriculture instructional program, a generalization about the effectiveness of demonstrations on the teaching of vocational agriculture was made. This generalization is that the vocational agriculture students taught using demonstrations achieved as well as or better than students taught the same subject matter without the use of demonstrations.

A comment should be made about the validity of measuring the effectiveness of demonstrations with only the four subject matter post-tests. Although they were found to be reliable and their validity verified by subject matter experts, proficiency of the skills learned by the students cannot be accurately measured by an objective test score. It would have been helpful to have had performance tests that would have measured the proficiency of the students in performing the skills and practices

taught. The lack of funds and time did not permit the development and administration of this type of measurement instruments.

The application of the demonstration method in the treatment group merits further discussion. The use of 39 demonstrations in teaching the four subject matter may well have been an over use of demonstrations. Also, some of the subject matter areas lent themselves to the use of demonstration method more than others. Due to the design of the study there was no laboratory time included for the application by the student of what he had learned. Student application immediately following the demonstration has been shown to reinforce the demonstration.

Since the teacher was an intricate part of the demonstration, uniform application of the demonstrations was difficult to achieve. Careful training of the teachers and supervision of the treatment schools were used in an attempt to get uniform application of the treatment. However, since the demonstrations were given by each instructor, there was the possibility of an interaction between the demonstrations and the instructor. This interaction was in part controlled by randomization of schools to the two groups. However, large variation between schools within groups would indicate that there were differences due to the instructor, the school, or an interaction of these variables with the treatment that were not completely accounted for.

Examination of the geographical locations of the participating schools revealed that all but one of the control schools were located in the northwest part of the state. The demonstration schools were distributed in the southwest and north central areas of Iowa. Northwest Iowa is one of the most fertile farmland areas in Iowa, whereas, the

southwest part of Iowa is somewhat less productive. This is reflected in the average number of crop acres and animal units for the students' home farms as the control group means were higher for these variables than were those of the demonstration group. Therefore, it is recommended that this study be replicated using a random sample stratified by economic areas in order to attempt to equate the treatment groups with respect to these factors.

There should be a replication of this study using a larger number of schools per treatment group in order for randomization to properly function in equating the two groups. Also further studies should be designed to control the instructor variable in order to insure a more uniform application of the demonstrations. This study should be replicated using performance tests and attitude scales as well as achievement tests to evaluate the effectiveness of demonstrations on teaching in vocational agriculture. Since the results of this study were not uniform for all four subject matter areas studied, studies similar to this one should be conducted using other subject matter units, different demonstrations, different instructors, and different schools and students.

Similar studies should also be conducted that randomize individual students and block for the instructor variable in order to more carefully study the effect of demonstrations on individual students. Further research is needed to identify and measure individual student characteristics and related variables that have an effect on student learning. Research is also needed to identify those characteristics possessed by successful teachers.

The findings of this study provide information concerning the use of

demonstrations in teaching vocational agriculture. These findings should be of value to those who are concerned with instruction in vocational agriculture and related fields. Vocational agriculture instructors should be encouraged to incorporate demonstrations in their instructional programs as they have been found to be an effective instructional method. These findings should encourage teacher educators to give greater emphasis to the demonstration method in both pre-service and in-service teacher education.

The implications of this study could be condensed into the following summary statements:

1. Vocational agriculture instructors should be encouraged to incorporate demonstrations in their instructional programs.
2. Teacher educators should place more emphasis on the demonstration method in both pre-service and in-service teacher education.
3. The demonstration method can be used effectively in teaching subject matter areas other than agricultural mechanics.
4. The teacher is an intricate part of the demonstration and therefore the demonstration method may be more successful for some teachers than others.
5. Students from larger and more progressive farms tend to achieve higher when taught using demonstrations.
6. Students with fewer siblings tend to achieve higher when taught using demonstrations.
7. Students with high mechanical interest and aptitudes tend to achieve higher when taught agricultural mechanics using demonstrations.

8. Demonstrations are more effective when given to smaller classes.
9. Since different variables were found to be associated with achievement in different subject matter areas, teachers must be careful to identify those related variables and develop their instructional programs to allow for these differences for the specific subject matter areas they teach.
10. Studies similar to this one should be conducted in other subject matter areas.
11. Further research is needed to determine the optimum length of a demonstration and the optimum size to which a demonstration should be presented.

SUMMARY

This study was designed to evaluate the effectiveness of demonstrations on instruction in vocational agriculture by comparing instruction using demonstrations with instruction without the use of demonstrations in teaching the same units of subject matter.

The study was conducted as a segment of a larger project which investigated, experimentally, the effectiveness of selected resources and techniques on instruction in vocational agriculture. The project was conducted in cooperation with the Department of Agricultural Education and the Iowa Agriculture and Home Economics Experiment Station of Iowa State University, the Vocational Agriculture Section of the Department of Public Instruction and the Iowa Research Coordinating Unit.

Iowa high schools offering an approved four year program of vocational agriculture were identified. From the list of qualified schools, six schools were randomly assigned to the demonstration group and six schools were randomly assigned to the control group.

An appropriate unit of instruction was selected for each of the four high school grade levels. These units of instruction included animal health for the ninth grade, commercial fertilizers for the tenth grade, small gasoline engines for the eleventh grade and farm credit for the twelfth grade. A three-week teaching outline for each of the subject matter units was developed which provided overall objectives, day-by-day objectives and reading assignments. Uniform reference material was also provided for all schools in the project so that the only variation in instruction was the use of the demonstrations in the treatment group.

Thirty-nine demonstrations in all , including the use of actual materials, objects, mock-ups, charts and specimens, were developed for classroom presentation. Demonstrations were developed in each of the four subject matter areas where the demonstration method could be effectively used as a teaching technique. Five demonstrations were prepared for the animal health unit, nine for the commercial fertilizers unit, nine for the small gasoline engines unit and six for the farm credit unit. Teaching outlines were prepared for each of the demonstrations and given to the instructors in the treatment group.

The participating teachers received two training sessions prior to the experiment. The first meeting was held to explain the purpose and design of the study. The second meeting was held to familiarize the teachers with the demonstrations to be tested and train them in the use of these demonstrations. The control schools were also informed of what they could and could not do while teaching the four units.

The experiment was conducted over a three-week period beginning March 21, 1969. Prior to the experiment the following tests were administered by each of the school counselors:

1. Otis Quick-Scoring Mental Ability Test
2. Kuder General Interest Survey
3. Nebraska Agricultural Achievement Test
4. Differential Aptitude Test - Mechanical Section
5. Differential Aptitude Test - Abstract Section
6. Differential Aptitude Test - Verbal Section

A questionnaire was also administered to obtain data on the students socio-economic background.

All students involved in the study were given a pre-test just prior to the beginning of the three-week instructional period and a post-test upon completion of the instruction period. The post-test was the dependent variable used for all analyses.

An attempt was also made to control the possible variations due to instructor differences from school to school. It was felt that the students' post-test scores may have been affected by the teaching ability of the instructors. Therefore, the Minnesota Teacher Attitude Inventory score and years of teacher tenure in the present school for each instructor were utilized in this study.

Since the schools rather than students were randomly assigned, class means became the experimental units and were the observations used in all comparisons of the treatment and control groups. Analysis of variance, two-factor experiment with repeated measures and analysis of covariance were used in comparing the two treatments. In addition, product-moment correlations were computed to determine the relationships between variables related to student achievement and the post-test scores of individual students.

Careful examination of the mean pre-test scores revealed that the control group had higher pre-test mean scores for the commercial fertilizers and farm credit units. The demonstration group had higher mean pre-test scores for the animal health and small gasoline engines units. However, single-classification analysis of variance computed for each subject matter area revealed that none of these differences were large enough to be significant.

The analysis of the two-factor experiment with repeated measures of

pre-test and post-test scores provided a test for determining if there was a gain in knowledge over the three-week experimental period. Highly significant gains in knowledge in all four of the subject matter areas were found.

The two-factor experiment analysis also compared the magnitude of gain in knowledge from the pre-test to the post-test for the demonstration and control groups. The analyses revealed that there was no significant difference in the amount of knowledge gained by the two groups in any of the four subject matter areas. However the control group post-test scores for all four units were higher than those for the demonstration group. The control group mean post-test scores were 57.57 for animal health, 48.26 for commercial fertilizers, 68.44 for small gasoline engines and 64.44 for farm credit. The demonstration mean post-test scores for the same respective units were 54.27, 43.38, 63.08 and 59.49.

Analysis of covariance computed on the animal health post-test scores of the demonstration and control groups revealed no significant differences between the two groups. However, the use of verbal reasoning aptitude, animal units and department size as covariates resulted in an adjusted mean post-test score for the demonstration group that was 6.46 points higher than that of the control group. Using the same three covariates, the adjusted animal health post-test mean for the demonstration group was 59.15 as compared to 52.69 for the control group.

The greatest adjustment of the commercial fertilizers post-test means resulted when mean agricultural achievement scores, crop acres and years of teacher tenure were used as covariates. The demonstration group adjusted mean was 51.61 as compared to 39.93 for the control group.

Analysis of covariance revealed that this difference was not significant. The three other analysis of covariance tests computed on the commercial fertilizers post-test scores also indicated no significant differences between the two groups.

For small gasoline engines the effect of the covariates used was small. Only the combination of mean agricultural achievement scores, animal units and department size as covariates, had a notable effect. Analysis of covariance using these three covariates resulted in a non-significant difference of only .02 between the adjusted post-test means of the demonstration and control groups.

The results of the analysis of covariance tests computed on the farm credit mean post-test scores for the demonstration and control groups revealed that the difference between the two groups was not significant. However, all four analyses resulted in the adjustment of the mean post-test scores in favor of the demonstration group. When the initial differences between the mean farm credit post-test scores for the two groups were adjusted with respect to the Minnesota Teacher Attitude Inventory scores and years of teacher tenure, the demonstration group mean was 64.07 as compared to 59.87 for the control group. The calculated F value of 4.79 was not significant at the .05 level of confidence.

A secondary purpose of this study was to determine the factors related to student achievement in vocational agriculture when taught using demonstrations. Correlation coefficients were computed between related student characteristics and individual student post-test scores for each of the four subject matter areas. In general the same types of

students who achieved well when taught with demonstrations did well when taught without the use of demonstrations.

Nineteen variables were found to be significantly correlated with the animal health post-test scores. The following variables were found to be most highly correlated with the animal health post-test for the demonstration group: pre-test (.8735), outdoor interest (.8620), number of siblings (-.8540), mechanical reasoning aptitude (.8417) and social service interest (.8083).

All 19 variables were again found to be significantly correlated with the commercial fertilizers post-test scores. The most highly correlated variables for the demonstrations group were: pre-test (.8840), clerical interest (.8043), outdoor interest (.8037), mechanical interest (.7878) and number of siblings (-.7714). The relationship of most of the variables to the commercial fertilizers post-test scores were similar for both the demonstration and control groups.

For small gasoline engines, all of the variables except the intelligence quotient scores had significant r values when compared with the post-test scores for both the demonstration and control groups. In the demonstration group, positive r values greater than .8100 were found between the post-test and (1) pre-test (.9303), (2) outdoor interest (.9105), (3) mechanical interest (.8678), and (4) mechanical reasoning aptitude (.8466). A negative r value of -.8946 was observed between the small gasoline engines post-test and number of siblings.

The r values for all 19 variables when compared with the post-test scores were significant in the farm credit unit. The most highly correlated variables for the demonstration group were: outdoor interest

(.9296), agricultural achievement scores (.8847), pre-test (.8660), computational interest (.8640), and mechanical interest (.8459). Negative correlations were observed between the farm credit post-test and (1) number of siblings (-.8401), and with (2) intelligence quotient scores (-.4343) for the demonstration group. Similar r values for each of the variables were also found for the control group.

The findings of this study can be condensed into the following summary statements:

1. There was no difference between the students' prior knowledge of the subject matter in the demonstration and control schools as measured by the pre-test.
2. In both the demonstration and control groups, there was a highly significant gain in knowledge for all four subject matter areas from the pre-test to the post-test,
3. There was no difference between the two groups in the magnitude of change in knowledge from the mean pre-test to the post-test scores.
4. All analyses comparing the achievement of the vocational agriculture classes taught using demonstrations to those taught without the use of demonstrations as measured by the post-test scores revealed no significant differences between the two types of instruction.
5. Although there was no significant difference between the two groups, analysis of covariance resulted in the demonstration group's adjusted mean post-test scores being higher than the

control group's adjusted mean post-test scores in all four subject matter areas.

6. Pre-test, outdoor interest, number of siblings, mechanical reasoning aptitude and social service interest were the variables found to be most highly correlated with the individual animal health post-test scores when taught using demonstrations.
7. Pre-test, clerical interest, outdoor interest, mechanical interest and number of siblings were the variables found to be most highly correlated with the individual commercial fertilizers post-test scores when taught using demonstrations.
8. Pre-test, outdoor interest, mechanical interest, mechanical reasoning aptitude and number of siblings were the variables found to be correlated to the greatest extent with the individual small gasoline engines post-test scores when taught using demonstrations.
9. Outdoor interest, agricultural achievement, pre-test, computational interest and mechanical interest were the variables found to be most highly correlated with the individual farm credit post-test scores when taught using demonstrations.

The findings of this study indicate that the demonstration is an effective method in teaching vocational agriculture. Vocational agriculture instructors should be encouraged to use demonstrations in their instructional programs and teacher educators should be encouraged to give greater emphasis to the demonstration method in both pre-service and in-service teacher education.

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APPENDIX A

ANIMAL HEALTHProblem Area Outline by DaysDay

- | | |
|--------|---|
| 1 | The Economic Importance of Livestock Diseases and Parasites |
| 2 | Factors in Maintaining Animal Health |
| 3 & 4 | Causes, Symptoms, Prevention and Control of Major Cattle Diseases |
| 5 | Life Cycles, Symptoms, Prevention and Control of Major Cattle Parasites |
| 6 & 7 | Causes, Symptoms, Prevention and Control of Major sheep Diseases |
| 8 | Life Cycles, Symptoms, Prevention and Control of Major Sheep Parasites |
| 9 & 10 | Casues, Symptoms, Prevention and Control of Major Swine Diseases |
| 11 | Life Cycles, Symptoms, Prevention and Control of Major Swine Parasites |
| 12 | Planning a General Livestock Health Program |
| 13 | Occupational Roles of the Veterinarian, Farmer, and Other Animal Health Workers |
| 14 | Summary and Review |
| 15 | Post-Test |

ANIMAL HEALTHBehavioral Objectives: (understandings and abilities)

- Understanding of:
- 1) The relation between control of diseases and parasites with efficient production of livestock
 - 2) The types, causes, symptoms, prevention and control of the major diseases and parasites of livestock
 - 3) The occupational roles of the veterinarian, farmer, and other animal health workers
 - 4) The possibilities for employment in occupations requiring a knowledge of animal diseases and parasites
- Ability to:
- 1) Recognize normal and abnormal health conditions prevalent in livestock and livestock production
 - 2) Plan an effective program for controlling livestock diseases and parasites
 - 3) Maintain desirable animal health conditions for livestock

ANIMAL HEALTHDay 1

1. PROBLEM AREA: The Economic Importance of Livestock Diseases and Parasites

Objectives:

To develop an understanding of:

- a. The importance of livestock diseases and parasites upon profitable livestock production
- b. The amount of damage done to livestock and livestock products by diseases and parasites
- c. The cost of controlling livestock diseases and parasites

References:

- a. Animal Health, Ch. 1, pp. 1-6
- b. Animal Health Handbook, pp. 2-3

Day 2

2. PROBLEM AREA: Factors in Maintaining Normal Animal Health

Objectives:

To develop an understanding of:

- a. The physical characteristics of the healthy animal
- b. Characteristics that indicate abnormal health and behavior of animals
- c. Proper management steps in preventing and controlling livestock diseases and parasites
- d. Desirable livestock health conditions

To develop an ability to:

- a. Recognize normal and abnormal livestock and livestock conditions
- b. Determine when an animal needs medical attention

References:

- a. Animal Health, Ch. 2, pp. 7-12
- b. Animal Health Handbook, pp. 43-45, 49-50, 87-90, 93-95, 105-106, 109-110

ANIMAL HEALTHDays 3 and 4

3. PROBLEM AREA: Causes, Symptoms, Prevention, and Control of Major Cattle Diseases

Objectives:

To develop an understanding of:

- a. The types of cattle diseases
- b. Causes, symptoms, treatment, and prevention of the following diseases of cattle:

- | | |
|---------------------------|----------------|
| 1. Brucellosis | 8. Calf Scours |
| 2. Shipping Fever Complex | 9. Warts |
| 3. Foot Rot | 10. Pneumonia |
| 4. Pinkeye | 11. Milk Fever |
| 5. Ringworm | 12. Ketosis |
| 6. Mastitis | 13. Bloat |
| 7. Leptospirosis | |

To develop an ability to recognize conditions of cattle that warrant calling a veterinarian

References:

- a. Animal Health, Ch. 3, pp. 13-17; Ch. 4, pp. 18-29

Day 5

4. PROBLEM AREA: Life Cycles, Symptoms, Prevention, and Control of Cattle Parasites

Objectives:

To develop an understanding of:

- a. The types of cattle parasites
- b. The life cycles, symptoms, prevention, and control of major cattle parasites

- | | |
|----------------|------------------|
| 1. Screw worms | 4. Stomach worms |
| 2. Grubs | 5. Lice |
| 3. Flies | |

To develop an ability to:

- a. Recognize parasite infestations in cattle
- b. Treat cattle parasites
- c. Control cattle parasites

ANIMAL HEALTHDay 5 (continued)

References:

- a. Animal Health, Ch. 7, pp. 49-52; Ch. 8, pp. 53-58

Days 6 and 7

5. PROBLEM AREA: Causes, Symptoms, Prevention, and Control of Major Sheep Diseases

Objectives:

To develop an understanding of:

- a. The types of sheep diseases
- b. Causes, symptoms, treatment, and prevention of the following diseases of sheep:

1. Foot Rot	3. Sore Mouth	5. Lambing
2. Mastitis	4. Overeating Disease	Paralysis
		6. Bloat

To develop an ability to recognize disease conditions in sheep that warrant calling a veterinarian

References:

- a. Animal Health, Ch. 3, pp. 13-17; Ch. 5, pp. 30-35

Day 8

6. PROBLEM AREA: Life Cycles, Symptoms, Prevention, and Control of Major Sheep Parasites

Objectives:

To develop an understanding of:

- a. The types of sheep parasites
- b. The life cycles, symptoms, prevention, and control of the following major sheep parasites:

1. Screw Worm	5. Stomach Worm
2. Lice	6. Tapeworms
3. Ticks	7. Coccidiosis
4. Scabbies	

ANIMAL HEALTHDay 8 (continued)

Objectives: (continued)

To develop an ability to:

- a. Recognize animal parasite infestations in sheep
- b. Treat sheep parasites
- c. Control sheep parasites

References:

- a. Animal Health, Ch. 7, pp. 49-50; Ch. 9, pp. 59-66

Days 9 and 10

7. PROBLEM AREA: Causes, Symptoms, Prevention, and Control of Major Swine Diseases

Objectives:

To develop an understanding of:

- a. The types of swine diseases
- b. Causes, symptoms, treatment, and prevention of the following diseases of swine:

- | | |
|-------------------------------------|------------------|
| 1. Cholera | 5. Brucellosis |
| 2. Erysipelas | 6. Flu |
| 3. Chronic Mycoplasmal
Pneumonia | 7. TGE |
| 4. Atrophic Rhinitis | 8. Leptospirosis |
| | 9. MMA |

To develop an ability to recognize disease conditions in swine that warrant calling a veterinarian

References:

- a. Animal Health, Ch. 3, pp. 13-17; Ch. 6, pp. 36-48

ANIMAL HEALTHDay 11

8. PROBLEM AREA: Life Cycles, Prevention and Control of Major Swine Parasites

Objectives:

To develop an understanding of:

- a. The types of swine parasites
- b. The life cycles, symptoms, prevention, and control of the following major swine parasites:

- | | |
|--------------|----------|
| 1. Ascarids | 3. Mange |
| 2. Lungworms | 4. Lice |

To develop an ability to:

- a. Recognize parasite infestations in swine
- b. Treat swine parasites
- c. Control swine parasites

References:

- a. Animal Health, Ch. 7, pp. 49-50; Ch. 10, pp. 67-71

Day 12

9. PROBLEM AREA: Planning a General Livestock Health Program

Objectives:

To develop an understanding of:

- a. The role of sanitation in an animal health program
- b. The importance of preventive medicine

To develop an ability to:

- a. Plan general livestock health programs
- b. Evaluate current livestock health programs

References:

- a. Animal Health, Ch. 11, pp. 73-80
- b. Animal Health Handbook, pp. 6-7

ANIMAL HEALTHDay 13

10. PROBLEM AREA: Occupational Roles of the Veterinarian, Farmer and Other Animal Health Workers

Objectives:

To develop an understanding of:

- a. The occupational roles for veterinarians, farmers, and other animal health workers
- b. Opportunities for employment in the field of animal health

To develop an ability to care for sick animals

References:

- a. Animal Health, Ch. 12, pp. 81-87
- b. Animal Health Handbook, pp. 36-38

Day 14

11. PROBLEM AREA: Summary and review

Objectives:

To review previously covered material and answer student questions

References:

- a. All previous assignments

COMMERCIAL FERTILIZERSProblem Area Outline by Days

<u>Day</u>	
1	Influence of Fertilizers on Farming
2 & 3	Essential Plant Food Elements and Their Function in Plant Growth
4	Hunger Signs of Crops
5 & 6	Taking a Soil Sample
7	Liming to Correct Soil Acidity
8 & 9	Understanding the Soil Test Report
10	Determining the Amount of Nutrients Available in the Soil
11	Determining Fertilizer Application Rates
12 & 13	Selecting Fertilizer Materials to Fill Nutrient Needs
14	Summary and Review
15	Post-Test

COMMERCIAL FERTILIZERSBehavioral Objectives: (understandings and abilities)

- Understanding of:
- 1) The influence of fertilizers on farming
 - 2) The essential plant food elements and their function in plant growth
 - 3) The effect of soil acidity on crop production

- Ability to:
- 1) Recognize hunger signs of crops
 - 2) Take a soil sample
 - 3) Correct soil acidity by liming
 - 4) Interpret the soil test report
 - 5) Determine the amount of nutrients available in the soil
 - 6) Determine fertilizer application rates
 - 7) Select fertilizer materials to fulfill nutrient needs

COMMERCIAL FERTILIZERSDay 1

1. PROBLEM AREA: Influence of Fertilizers on Farming

Objectives:

To develop an understanding of:

- a. The benefits to be gained from fertilizing
- b. The increase in fertilizer use in Iowa and the local community
- c. The need to maintain soil fertility
- d. How plant food is lost

References:

- a. Our Land and Its Care, pp. 2-21, 62-65, 67-68
- b. Fertilizer Use in Iowa Reaches Record Level, Iowa Farm Service Publication No. 1231

Days 2 and 3

2. PROBLEM AREA: Essential Plant Food Elements and Their Function in Plant Growth

Objectives:

To develop an understanding of:

- a. The essential plant food elements and their function in plant growth
 - (1) Primary nutrients and their function in plant growth
 - (a) The function of nitrogen in plant growth
 - (b) The function of phosphorus in plant growth
 - (c) The function of potassium in plant growth
 - (2) Secondary plant nutrients and their function in plant growth
 - (a) The function of calcium in plant growth
 - (b) The function of magnesium in plant growth
 - (c) The function of sulfur in plant growth
 - (3) Micro plant nutrients and their function in plant growth

References:

- a. Our Land and Its Care, pp. 23, 26-34
- b. Growth and Nutrient Uptake by Corn, Pamphlet 277

COMMERCIAL FERTILIZERSDay 4

3. PROBLEM AREA: Hunger Signs of Crops

Objectives:

To develop an understanding of nutrient requirements of various crops

To develop an ability to:

- a. Recognize primary plant food deficiencies
- b. Recognize secondary plant food deficiencies
- c. Recognize micro plant food deficiencies

References:

- a. Our Land and Its Care, pp. 36-39
- b. Be Your Own Corn Doctor -- NPK Bulletin

Days 5 and 6

4. PROBLEM AREA: Taking a Soil Sample

Objectives:

To develop an understanding of:

- a. The effect of soil types on soil fertility
- b. The effect of cropping sequence on soil fertility
- c. Where soil samples may be analyzed

To develop an ability to:

- a. Take a uniform and representative soil sample
- b. Correctly fill out the soil and cropping information sheet

References:

- a. How to take a Soil Sample, NPK Leaflet
- b. Our Land and Its Care, p. 42
- c. Soil and cropping Information Sheet, ST-8

Day 7

5. PROBLEM AREA: Liming to Correct Soil Acidity

Objectives:

To develop an understanding of:

- a. What is soil acidity and how it is measured
- b. The optimum pH range for farm crops
- c. The effective calcium carbonate equivalent (ECCE) of various liming materials

To develop an ability to:

- a. Correct soil acidity
- b. Select proper liming materials
- c. Determine proper liming rates

References:

- a. Our Land and Its Care, pp. 18-19
- b. Understanding Your Soil Test Report, Pamphlet 429, p. 5
- c. Your Limestone Recommendation, (St-2)

Days 8 and 9

6. PROBLEM AREA: Understanding the Soil Test Report

Objectives:

To develop an understanding of:

- a. What a soil test measures
- b. How the amount of N, P, and K are determined by a soil test

To develop the ability to:

- a. Select the correct soil test nutrient recommendation
- b. Adjust soil test recommendations to specific crop yields

References:

- a. Understanding Your Soil Test Report, Pamphlet 429, pp. 1-4
- b. Soil Test Report, (ST-9)

COMMERCIAL FERTILIZERSDay 10

7. PROBLEM AREA: Determining the Amount of Nutrients Available in the Soil

Objectives:

To develop the ability to estimate:

- a. The nitrogen credits for 1st or 2nd corn following a legume
- b. The amount of carryover available from fertilizer applied the previous year
- c. The amount of nutrients supplied from manure that has been applied since soil was sampled

References:

- a. Understanding Your Soil Test Report, Pamphlet 429, pp. 1-4
- b. Modern Farmers Need to be Accountants in the Cornfield, Iowa Farm Service Publication No. 1049

Day 11

8. PROBLEM AREA: Determining Fertilizer Application Rates

Objectives:

To develop an understanding of the factors that affect fertilizer application rates:

- a. Nutrient requirements from soil test report
- b. Nutrients available in the soil

To develop the ability to:

- a. Calculate proper fertilizer application rates
- b. Convert P_2O_5 to Phosphorous
- c. Convert K_2O to Potassium

References:

- a. Understanding Your Soil Test Report, Pamphlet 429, pp. 2-4
- b. Better Names for "Phosphate" and "Potash", Iowa Farm Service Publication No. 1050

COMMERCIAL FERTILIZERSDays 12 and 13

9. PROBLEM AREA: Selecting Fertilizer Materials to Fill Nutrient Needs

Objectives:

To develop an understanding of the major sources of fertilizer materials available in the community

To develop the ability to:

- a. Change nutrient recommendations into amounts of a fertilizer grade
- b. Select fertilizer materials that will fulfill nutrient needs

References:

- a. Understanding Your Soil Test Report, Pamphlet 429, pp. 5-6
- b. Our Land and Its Care, pp. 44-45, 56, 57

Day 14

10. PROBLEM AREA: Review and Summary

Objectives:

To review previous material covered in this partial unit

References:

- a. Those cited for each of the problem areas studied

SMALL GASOLINE ENGINES

Problem Area Outline by DaysDay

- 1 Engine Principles - Two and Four-cycle Engines
- 2 Nomenclature - Compression Factors
- 3 Valves
- 4 Valve Timing - Camshafts
- 5 Rings
- 6 Measuring Devies
- 7 Carburetion
- 8 Carburetor Types
- 9 Carburetor Adjustment - Governors
- 10 Air Cleaners
- 11 Ignition Systems
- 12 Magneto Cycle
- 13 Preventative Maintenance
- 14 Trouble Shooting - Review
- 15 Post-Test

SMALL GASOLINE ENGINES

Behavioral Objectives: (understanding and abilities)

- Understanding of:
- 1) Basic principles of small engine operation
 - 2) Difference between two and four-stroke cycle engines
 - 3) Function of piston, rings, crankshaft, camshaft, and valves as related to compression
 - 4) Function of carburetor and component parts
 - 5) Function of small engine ignition systems and component parts
 - 6) Measuring devices used on small engines

- Ability to:
- 1) Identify basic small engine components
 - 2) Perform general maintenance on a small gasoline engine
 - 3) Trouble shoot a small gasoline engine
 - 4) Use various measuring and testing devices
 - 5) Use a service manual

SMALL GASOLINE ENGINESDay 1

1. PROBLEM AREA: Engine principles - Two and Four-Cycle Engines

Objectives:

To develop an understanding of:

- a. The intake stroke, compression stroke, power stroke and exhaust stroke in an engine
- b. The principles of operation of a two and four-cycle engine

References:

- a. General Theories of Operation, Briggs & Stratton, Corp., pp. 2-3
- b. Small Gasoline Engines Student Handbook, Penn. State Univ. pp. 1-3

Day 2

2. PROBLEM AREA: Nomenclature - Compression Factors

Objectives:

To develop an understanding of piston displacement and compression ratio as related to horsepower in a small engine

To develop an ability to:

- a. Identify main parts of small engines
- b. Calculate piston displacement and compression ratio

References:

- a. General Theories of Operation, Briggs & Stratton, Corp., p. 4
- b. Small Gasoline Engines Student Handbook, Penn. State Univ. p. 4

SMALL GASOLINE ENGINESDays 3 and 4

3. PROBLEM AREA: Valves, Valve Timing and Camshafts

Objectives:

To develop an understanding of:

- a. Valve operating conditions
- b. Valve failures

To develop an ability to:

- a. Identify parts of valve train
- b. Determine usable valve margin and valve seat tolerances

References:

- a. General Theories of Operation, Briggs & Stratton, Corp., pp. 4-7
- b. Small Gasoline Engines Student Handbook, Penn. State Univ., pp. 5-7

Day 5

4. PROBLEM AREA: Ring Adjustment

Objectives:

To develop an understanding of:

- a. The purpose of rings
- b. Ring types and each's function

To develop an ability to:

- a. Measure various ring clearances
- b. Identify types of rings

References:

- a. Small Gasoline Engines Student Handbook, Penn. State Univ., pp. 8-11

SMALL GASOLINE ENGINESDay 6

5. PROBLEM AREA: Measuring Devices

Objectives:

To develop an understanding of various measuring devices

To develop an ability to read micrometer and other measuring devices

References:

- a. Small Gasoline Engines Student Handbook, Penn. State Univ., pp. 12-19

Days 7, 8, and 9

6. PROBLEM AREA: Carburetion, Carburetor Types and Adjustment, and Governors

Objectives:

To develop an understanding of:

- a. Principles of operation of carburetors
- b. How gaseous mixture is controlled within the carburetor
- c. Governor types and operation

To develop an ability to:

- a. Identify basic parts of the carburetor
- b. Explain operation of various types of carburetors
- c. Governor types and operation

References:

- a. General Theories of Operation, Briggs & Stratton, Corp., pp 8-13, 20-21
- b. Small Gasoline Engines Student Handbook, Penn. State Univ., pp. 27-37

SMALL GASOLINE ENGINESDay 10

7. PROBLEM AREA: Air Cleaners

Objectives:

To develop an understanding of:

- a. The importance of an air cleaner
- b. The different types and principles of operations of air cleaners

To develop an ability to service various types of air cleaners

References:

- a. General Theories of Operation, Briggs & Stratton, Corp., p. 14
- b. Small Gasoline Engines Student Handbook, Penn. State Univ., pp. 37-39

Days 11 and 12

8. PROBLEM AREA: Ignition and the Magneto Cycle

Objectives:

To develop an understanding of:

- a. The purpose of ignition systems
- b. Principles of magneto-ignition systems
- c. A complete magneto cycle

To develop an ability to:

- a. Identify parts of magneto-ignition system

References:

- a. General Theories of Operation, Briggs & Stratton, Corp., pp. 15-18
- b. Small Gasoline Engines Student Handbook, Penn. State Univ., pp. 45-51

SMALL GASOLINE ENGINESDay 13

9. PROBLEM AREA: Preventative Maintenance

Objectives:

To develop an understanding of:

- a. The importance of maintenance on small gasoline engines
- b. Why clean, fresh, regular gasoline should be used in small gasoline engines

To develop an ability to:

- a. Determine and analyze engine problem by observation of spark plug
- b. Properly service engine at proper time (spark plugs, breaker points, air cleaners and oil)
- c. Properly prepare small gasoline engine for storage
- d. Follow a service and maintenance schedule

Reference:

- a. Small Gasoline Engines Student Handbook, Penn. State Univ., pp. 55-59

Day 14

10. PROBLEM AREA: Trouble Shooting and Review

Objectives:

To develop an understanding of procedures used in trouble shooting

To develop an ability to trouble shoot an engine

Reference:

- a. Small Gasoline Engines Student Handbook, Penn. State Univ., pp. 64-65

Problem Area Outline by Days

Day

- 1 Introduction to Credit, "Problem"
- 2 "Problem", Application for Loan (Financial Statement)
- 3 Budgeting Principles
- 4 Budgeting the Problem
- 5 Budgeting, Complete Application for Loan
- 6 Types of Loans
- 7 Sources of Credit - Short Term & Intermediate
- 8 Sources of Credit - Long Term - (Land)
- 9 Interest Rates and Loan Costs
- 10 Collateral - Short and Intermediate Term
- 11 Collateral - Long Term
- 12 Credit Instruments - Short Term - Intermediate
- 13 Credit Instruments - Long Term - (Land)
- 14 Summary and Review
- 15 Post-Test

FARM CREDITBehavioral Objectives: (understandings and abilities)

Understanding of: 1) The importance of credit in agriculture

2) Types of credit used for specific purposes

3) The sources of credit

4) Interest rates and loan costs

5) Credit instruments

6) The criteria used in granting farm credit

7) The criteria used to evaluate a credit source

8) The career potentials in farm credit

Ability to: 1) Use credit to increase farm income

2) Budget income and expenses to determine credit needs

3) Select correct credit source based on financial position
and needs

4) Calculate the cost of various types of loans

5) Use credit instruments

6) Prepare a financial statement

7) Plan a repayment schedule

FARM CREDITDays 1 and 2

1. PROBLEM AREA: The Problem

Objectives:

To develop an understanding of the need for credit

To develop an ability to:

- a. Analyze a farming situation and determine the financial position of the applicant
- b. Prepare a financial statement

References and Materials:

- a. Financing Farm & Ranch Activities, pp. 8-11, 15
- b. The Problem
- c. Financial statement form

Days 3, 4, & 5

2. PROBLEM AREA: Budgeting

Objectives:

To develop an understanding of budgeting principles

To develop an ability to budget a farm credit problem

References and Materials:

- a. Financing Farm & Ranch Activities, pp. 34, 36-37
- b. The Problem
- c. Budget Worksheet
- d. Application for loan

FARM CREDIT

Day 6

3. PROBLEM AREA: Types of Loans (based on length of loan in years)

Objectives:

To develop an understanding of:

- a. The three types of loans normally available
- b. Disadvantages and advantages of various types of credit

To develop an ability to classify credit requirements into loan types

References and Materials:

- a. Financing Farm & Ranch Activities, pp. 12-13

Days 7 & 8

4. PROBLEM AREA: Sources of Credit

Objectives:

To develop an understanding of:

- a. The sources of credit
- b. An understanding of the criteria used to evaluate a credit source

To develop an ability to determine the type of credit source to use

References and Materials:

- a. Financing Farm & Ranch Activities, pp. 32-41, 50-66

FARM CREDIT

Day 9

5. PROBLEM AREA: Interest Rates and Loan Costs

Objectives:

To develop an ability to calculate the costs of various types of loans

References and Materials:

- a. Financing Farm & Ranch Activities, pp. 18-19, 47-50

Days 10 & 11

6. PROBLEM AREA: Collateral

Objectives:

To develop an understanding of the criteria used in granting farm credit

To develop an ability to determine loan value of different types of collateral

References and Materials:

- a. Financing Farm & Ranch Activities, pp. 14-17, 44-47

FARM CREDIT

Days 12 and 13

7. PROBLEM AREA: Credit Instruments

Objectives:

To develop an understanding of the types of credit instruments

To develop an ability to use credit instruments

References and Materials:

- a. Financing Farm & Ranch Activities, pp. 19-29, 35-39
- b. Blank credit instrument forms

Day 14

8. PROBLEM AREA: Summary

Objectives:

To develop an understanding of the career potentials in farm credit work

To review previous problem area objectives

References and Materials:

- a. Financing Farm & Ranch Activities
- b. The Problem
- c. Budget Worksheet
- d. Application for loan
- e. Credit instruments

APPENDIX B

HOW TO IDENTIFY NORMAL AND ABNORMAL LIVESTOCK

I. OBJECTIVES:

A. To develop an understanding of:

1. The physical characteristics of the healthy animal.
2. Characteristics that indicate abnormal health and behavior of animals.

B. To develop an ability to:

1. Recognize normal and abnormal livestock and livestock conditions.
2. Determine when an animal needs medical attention.

II. EQUIPMENT AND MATERIALS NEEDED:

- A. A normal healthy pig or lamb.
- B. An abnormal or unhealthy pig or lamb (such as a runt).
- C. Student outline to normal and abnormal characteristics.

III. PROCEDURE:

A. Preparation:

1. Teacher - Be familiar with the characteristics of normal and abnormal livestock characteristics and be able to identify each. Secure a normal and abnormal animal such as a normal pig and an abnormal pig. Have the animals in the shop prior to class time.
2. Student - Assign the following reading to be completed prior to observing the demonstration:

a. Animal Health, Chapter 2, pp. 7-12

- B. Motivation: Show the normal and abnormal animals to the class. Ask the class to identify the differences between the two animals.
BRING OUT: There are several characteristics that are used to identify normal and abnormal animals.

- C. Presentation: Demonstrate the characteristics of a normal animal and those of an abnormal animal following the outline on the following page:

- D. Application: Have students evaluate the condition of the abnormal animal to see if they can diagnosis what is wrong with it.

IV. REFERENCES:

- A. Animal Health, Chapter 2, pp. 7-12

HOW TO IDENTIFY NORMAL AND ABNORMAL LIVESTOCK

CHARACTERISTIC

KEY POINTS

General Characteristics:

1. posture or stance
 - a. Normal animal
 1. Stands erect
 2. Calm disposition
 - b. Sick animal
 1. Usually quiet or restless disposition
 2. Abnormal posture
 - a. Stiffness
 - b. Ears upright
 - c. Tail semi-rigid
 - d. Eyes extended from the forehead
 - e. Inflammation of the feet
 - f. Lameness
 3. Animal appears to be warm on a cold day or cold on a warm day.
2. Movement
 - a. Normal animal moves about freely and normally.
 - b. Sick or abnormal animal
 1. Stiffness or lamesness
 2. Walks in circles
 3. Walks with head to one side or tilted.
3. Voice
 - a. A normal animal has a pleasant pleasing voice.
 - b. A sick animal will have a voice that is easily identified with pain or injury.
4. Appetite
 - a. A good appetite is one of the best indications of a healthy animal.
 - b. Sudden change in eating habits should be noted and watched carefully.

Specific Characteristics:

5. Skin and coat.
 - a. The coat of an animal should always be smooth and glossy and the hide pliable and loose.
 - b. Abnormalities in the skin and coat include:
 1. Patchiness of the hair coat.
 2. Abnormal sweating.
 3. Small sores
 4. Excessive itching.

HOW TO CONTROL AND TREAT MASTITIS

I. OBJECTIVES:

- A. To develop an understanding of the causes of mastitis:
- B. To develop the ability to:
 - 1. Prevent and control mastitis.
 - 2. Treat mastitis.

II. EQUIPMENT AND MATERIALS NEEDED:

- A. Sample of infected milk from a cow with mastitis
- B. Sample of a chlorine solution
- C. Sample of antibiotic ointment used for treating mastitis

III. PROCEDURE:

A. Preparation:

- 1. Teacher - Have a student bring a sample of mastitis infected milk. Secure a sample of chlorine disinfectant and ointment from local dairy or livestock supply store.
- 2. Student - Assign the following to be read prior to observing the demonstration:

- a. Animal Health, pp. 23
- b. Animal Health Handbook, pp. 58-60

- B. Motivation: Show students sample of mastitis milk and have them identify the cause of the thick, clotted, stringy milk. Discuss other symptoms of mastitis. Also discuss what causes mastitis.
- C. Presentation: Go through the procedure for controlling and treating mastitis outlined on the attached page:
- D. Application: Have students plan mastitis prevention programs for their dairy herds.

IV. REFERENCES:

- A. Animal Health, pp. 23
- B. Animal Health Handbook, pp. 58-60

HOW TO CONTROL AND TREAT MASTITIS

STEPS

KEY POINTS

1. If possible prevent mastitis
 - a. Remove all sources of udder injuries in lots and barns.
 - b. Avoid udder injuries from milking machines:
 1. Avoid excessive vacuum pressure in milking machines.
 2. Don't "over milk" the cows.
 - c.. After milking, dip teats in a chlorine solution.
2. If a case of mastitis is observed treat it immediately
 - a. Carefully milk out the infected quarters, preferably by hand(If machine is used, disinfect machine with chlorine solution when finished)
 - b. Inject antibiotic ointment into the affected quarters.
 - c. If the mastitis infection is severe, a veterinarian should be called.

HOW TO CONTROL CATTLE GRUBS

I. OBJECTIVES:

- A. To develop an understanding of the life cycle and symptoms of cattle grubs or warbles.
- B. To develop an ability to prevent and control cattle grubs.

II. EQUIPMENT AND MATERIALS NEEDED:

- A. Chart showing life cycle of the grub
- B. Samples of common chemicals used for controlling grubs.(Cousnaphos, neguron, ruelene, ronnel and rotenone)
- C. Sample of leather damaged by a grub(if possible)
- D. Specimens of the grub larvae

III. PROCEDURE:

A. Preparation:

- 1. Teacher - Secure samples of chemicals from local livestock supply store or veterinarian.
- 2. Student - Assign the following to be read prior to the demonstration:
 - a. Animal Health, pp. 49-58

B. Motivation: Show students piece of leather full of holes from grubs and ask them what caused the damage to the leather.

C. Presentation: Go through the procedure outlined for controlling cattle grubs on the attached page:

D. Application: Have the students inspect the cattle on their home farms for evidence of grubs.

IV. REFERENCE:

- A. Animal Health, pp. 49-58

HOW TO CONTROL CATTLE GRUBS

STEPS

KEY POINTS

1. Examine cattle for evidence of cattle grubs
 - a. Presents of swelling or lumps under the hide in the back from December to May.
 - b. By pressing down on these lumps, the grub larvae will usually pop out.
 - c. The presence of heel flies during late spring and early summer.
2. Become familiar with the life cycle of the grub
 - a. Heel fly stage - the mature female fly lays her eggs to the hair of the animals lower legs and belly.
 - b. Larva stage - the eggs hatch in a few days and migrate through the connective tissue to the back region.
 - c. Pupa stage - the larva cuts a hole in the hide, completes its development and drops off to the ground where it pupates and waits for warmer weather again.
3. Determine the best times to treat for control of grubs
 - a. Cattle being shipped into Iowa from southern states should be treated before September 1.
 - b. Iowa cattle should be treated after August 15 and before November 1.
4. Use approved methods to control grubs
 - a. Feed additive: Ronnel is the active ingredient in feed additive treatments and is available in several formulations fed 7, 10 or 14 days.
 - b. Pour on: the following are available for this treatment:
 1. Co-Ral
 2. Neguvon
 3. Ruelene
 4. Famphur(Warbex)
 - c. Spray: the oldest method and has the most failures. The following are available:
 1. Co-Ral
 2. Neguvon
 3. Ruelene
 - d. Whatever method is selected be sure to follow manufacturer's recommendation as to time rate and method of application.

HOW TO CONTROL ROUNDWORMS IN SWINE

I. OBJECTIVES:

- A. To develop an understanding of the life cycle of the roundworm(ascarids).
- B. To develop an ability to control round-worms in swine.

II. EQUIPMENT AND MATERIALS NEEDED:

- A. Specimens of ascarids
- B. Samples of the following wormers:
 - 1. Dichlorovos
 - 2. Hygromycin
 - 3. Piperuzine
- C. Chart showing life cycle of the roundworm

III. PROCEDURE:

- A. Preparation:
 - 1. Teacher - Secure samples of wormers from local livestock supply sources and veterinarian. be familiar with life cycle of the roundworm.
 - 2. Student - Assign the following reading to be completed prior to observing the demonstration:
 - a. Animal Health, pp. 69-70
- B. Motivation: Show students a specimen of the roundworm.
- C. Presentation: Go through the procedure outlined on the attached page for controlling roundworms:

IV. REFERENCES:

- A. Animal Health, pp. 69-70

HOW TO CONTROL ROUNDWORMS IN SWINE

STEPS

KEY POINTS

1. Become familiar with the life cycle of the roundworm
 - a. The female worm lays up to 1,400,000 eggs a day in the intestines which pass out of the body in the feces.
 - b. Eggs develop embryos in about 14 days.
 - c. When eaten by the pig, the larvae hatch in the small intestine, penetrate intestinal wall, migrate in the blood stream through liver, heart and lungs.
 - d. After reaching the lungs in about 10 days, larvae are coughed up and swallowed by the pig.
 - e. Larvae return to small intestine where they develop to egg-laying maturity in 2 to 2½ months.
2. Keep baby pigs from eating worm eggs
 - a. This is hard if not impossible to do.
 - b. Commonly used disinfectants will not kill the roundworm eggs.
 - c. The eggs are about the size of a pin point and can be spread by the wind.
3. Eliminate the source of the eggs by killing the adult worms in the pigs
 - a. Feed hydromycin continuously:
 - (1) Hygromycin must be fed for 30 days to remove all worms.
 - (2) This program is designed to protect baby pigs from roundworm eggs.
 - (3) Many commercial feeds contain hydromycin.
 - b. Treat pigs every 60 days with piperazine wormers.
 1. These wormers are easily given by mixing into drinking water or feed.
 2. Treatment every 60 days will prevent any worms from growing up.
 - c. Treat pigs with dichlorovos(ATGARD)
 1. Dichlorovos kills the worms before treated swine expell them.
 2. Worm pigs at 5 to 6 weeks of age with dichlorovos.
 3. Mix dichlorovos into meal-type(non-pelleted) rations just prior to administration.

HOW TO TREAT WOUNDS AND OPEN SORES

I. OBJECTIVES:

- A. To develop an understanding of the necessity of promptly treating wounds and open sores
- B. To develop the ability to treat wounds and open sores

II. EQUIPMENT AND MATERIALS NEEDED:

A. Samples of the following disinfectants:

- 1. Tincture of iodine solution
- 2. Alcohol
- 3. Boric acid
- 4. Commercial disinfectants

III. PROCEDURE:

A. Preparation:

- 1. Teacher - Secure samples of disinfectants from veterinarian or local livestock supply store.
- 2. Student - Assign the following to be read prior to the demonstration:
 - a. Animal Health, pp. 73-80
 - b. Animal Health Handbook, pp. 6-7

B. Motivation: Ask the class the following questions:

- 1. How do disease organisms enter a particular animal?
- 2. What are some ways of preventing these disease organisms from entering the animal?

C. Presentation: Go through the procedure for treating wounds and open sores outlined on the attached page:

D. Application: If possible have students treat wounds or sores such as:

- 1. Navels on new born animals
- 2. Wounds due to castrating or de-horning

IV. REFERENCES:

- A. Animal Health, pp. 73-80
- B. Animal Health Handbook, pp. 6-7

HOW TO TREAT WOUNDS AND OPEN SORES

STEPS

KEY POINTS

1. Identify those animals with wounds or open sores
 - a. Inspect herd daily to find animals that may need treatment.
 - b. Isolate wounded animals or animals with open sores from the rest of the herd in a clean dry lot.
 - c. Treat the navels of newborn animals soon after birth.
 - d. Disinfect wounds from castration and de-horning.
2. Treat the wound or open sore thoroughly
 - a. Clean the animal thoroughly before applying the disinfectant using hot soapy water.
 - b. Choose an appropriate disinfectant:
 1. Iodine
 2. Alcohol
 3. Boric acid
 4. Commercial disinfectant
 - c. Check the strength of the disinfectant. Many disinfectants need to be diluted before using. FOLLOW THE DIRECTIONS.
 - d. Apply the disinfectant to the wound or sore thoroughly.

COMMERCIAL FERTILIZERS

Day 1 - Motivational Demonstrations

1. Balanced Fertility

Purpose: The purpose of this demonstration is to show that if one or more of the major plant-food elements is deficient in the soil, plants can not attain maximum growth.

Materials: Three green blocks representing nitrogen, two blue blocks representing phosphorous and five orange blocks representing potassium. Magnets should be attached to the blocks to hold them on the magnetic board.

Procedure: Build the blocks one on top of the other to represent a plant, alternating the colors. Use green (N) block first, then a blue one (P), then an orange one (K). Repeat this a second time and start a third time, but you will run out of blue blocks and cannot proceed even though you have some orange (K) blocks left. How could you increase the height of your pile or the growth of a plant? Could you do it by adding more blue blocks (P)?

2. A Whale of a Profit From a Whale of a Yield

Purpose: To illustrate how certain practices will mean a whale of a yield and a whale of a profit.

Materials: A picture of a whale, a bushel basket overflowing with corn and a dollar bill for use on a magnetic or flannel board.

Procedure: Use the picture of a whale with an overflowing bushel basket of corn above the whale's water spout and a dollar bill above the bushel basket.

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HOW TO TAKE A SOIL SAMPLE

I. OBJECTIVE:

To develop the ability to take a uniform and representative soil sample

II. EQUIPMENT AND MATERIALS NEEDED:

- A. Soil probe or auger
- B. Clean non-metallic pail
- C. Clipboard and paper for mapping fields
- D. Soil sample bags and information sheets

III. PROCEDURE:

A. Preparation:

- 1. Teacher - Assemble materials and arrange for a field to use that is near the school (the school lawn might be used)
- 2. Student - Assign the reading of the following to be completed prior to the class period:

- a. How to Take a Soil Sample, NPK Leaflet
- b. Our Land and its Care, p. 42

B. Motivation:

Show the class a soil sample bag and emphasize that the small amount of soil put in this bag must be representative of the whole field that the sample represents. Therefore it is very important that the sample be taken in a way that will make it as representative of the field as possible if the soil test is to be accurate.

C. Presentation:

Demonstrate the procedure for taking a representative soil sample following the outline given below:

<u>STEPS</u>	<u>KEY POINTS</u>
1. Obtain materials needed	<ul style="list-style-type: none">a. Instructions for taking soil samplesb. Sample bagsc. Information sheets
2. Use proper sampling tools	<ul style="list-style-type: none">a. Soil probe or auger is recommendedb. Spade and trowel may be usedc. Secure <u>clean non-metallic pail</u>
3. Don't sample unusual areas	<ul style="list-style-type: none">a. Dead furrowsb. Old straw or haystack bottomsc. Old fence linesd. 50 pace strips along lime rock roads (receives dust from road)

STEPS

KEY POINTS

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- | | |
|---|--|
| 4. Divide fields into areas for sampling | a. One sample shouldn't represent over 5 to 10 acres.
b. Sample separately, all acres differing in crop growth, soil color or past management.
c. Ignore areas too small to be limed or fertilized separately. |
| 5. Draw a map of field being sampled | a. Identify unusual areas on the map
b. Mark location of samples |
| 6. Take composite samples from each area. | a. Scrape away surface litter
b. Insert probe or auger to plow depth (about 6 inches)
c. Take at least 15 - 20 such cores in each area.
d. Where row crops are planted, take soil between rows.
e. Sampling depth in pastures usually should be only about 2 inches. |
| 7. Mix sample well in clean pail | a. Collect the 15 to 20 cores per sample in clean non-metallic pail
b. Mix cores thoroughly
c. Fill plastic lined bag to level indicated on bag
d. Identify and number bags
e. Seal bags properly to insure that the sample will not dry out.
f. Mail sample to soil testing laboratory within 12 hours |

D. Application:

Have students take samples of one or more fields on their home farm

E. Evaluation:

Quiz students on procedure for taking a representative soil sample and note number of soil samples students take on their home farms.

IV. REFERENCES:

- A. How to Take a Soil Sample, NPK Leaflet
- B. Our Land and its Care, NPK, p. 42

HOW TO FILL OUT A SOIL AND CROPPING INFORMATION SHEET

I. OBJECTIVE:

To develop the ability to correctly fill out the soil and cropping information sheet

II. EQUIPMENT AND MATERIALS NEEDED:

- A. Soil samples and map of field sampled
- B. Soil survey map
- C. Cropping history for field sampled

III. PROCEDURE:

A. Preparation:

- 1. Teacher - Be familiar with soil and cropping information sheet and have information needed from the field sampled.
- 2. Student - Assign the reading of the following prior to the class period:
 - a. Our Land and Its Care, p. 42

B. Motivation: Ask the students the following questions:

- 1. What is the effect of soil type on soil fertility?
- 2. What is the effect of cropping sequence on soil fertility?
- 3. Why is it necessary to send an information sheet with a soil sample?

C. Presentation:

Demonstrate the correct way to fill out a soil and cropping information sheet following the attached procedure:

D. Application:

Have student fill out information sheets for soil samples they take on their home farms.

E. Evaluation:

Evaluate the completeness and accuracy of the information sheets the students fill out for the soil samples they take.

IV. REFERENCES:

- A. Our Land and Its Care, NPK Leaflet, p. 42
- B. Soil and Cropping Information Sheet, St-8

HOW TO FILL OUT A SOIL AND CROPPING INFORMATION SHEET

STEPS	KEY POINTS
1. Fill in personal identification section	<ul style="list-style-type: none"> a. Enter your name and address b. If you want the recommendations of local agriculturalist such as vo-ag instructor, enter his name.
2. Sample identification	<ul style="list-style-type: none"> a. Map fields and identify sample areas b. Give separate sample a number for identification c. Give number of acres represented by the respective samples.
3. Give soil description	<ul style="list-style-type: none"> a. Give soil type for each sample (This can be obtained from soil survey map) b. Estimate slope for each sample area. (Can estimate by no. of foot rise/100ft.) c. Indicate drainage G - if well drained F - if moderately wet(floods occasionally) P - if drainage is a problem d. Indicate whether it is bottom or upland soil e. Indicate depth of topsoil in inches
4. Indicate depth of plowing	<ul style="list-style-type: none"> a. Indicate depth in inches which field is normally plowed
5. Record previous fertilizer treatments	<ul style="list-style-type: none"> a. List actual pounds of N, P₂O₅ and K₂O applied last year. b. List tons of manure applied/acre in the last year. c. Give year of last lime application and the ECCE lbs/acre applied
6. Record crop history for sample	<ul style="list-style-type: none"> a. Give cropping history for past three years b. Give crop to be fertilized c. Give crop to be planted one year later
7. Send to soil testing laboratory	<ul style="list-style-type: none"> a. Enclose information sheet with soil samples and mail immediately to soil testing laboratory.

HOW TO DETERMINE PROPER LIMING RATES

I. OBJECTIVES:

- A. To develop an understanding of the effective calcium equivalent (ECCE) of various liming materials.
- B. To develop an ability to:
 1. Select proper liming material
 2. Determine proper liming rates

II. EQUIPMENT AND MATERIALS NEEDED:

- A. Samples of limestone of different fineness 4, 8 and 60 mesh
- B. (ECCE) ratings of the local lime sources
- C. Chalkboard and chalk

III. PROCEDURE:

A. Preparation:

1. Teacher - Obtain information and materials needed before class time and be familiar with procedure for calculating liming rates
2. Student - Assign the following reading assignment to be completed prior to the demonstration

- a. Your Limestone Recommendation, St-2
- b. Understanding Your Soil Test Report, page 5

- B. Motivation: Ask the students the following questions to emphasize the differences in types of liming materials and need for calculating liming rates

1. What is lime?
2. Show students the samples of lime and ask them what the difference is?
3. Why does the soil test report give lime recommendations in terms of calcium carbonate?

- C. Presentation: Demonstrate the procedure for determining proper liming rates following the attached procedure:

- D. Application: Have students figure liming rates using different liming materials

- E. Evaluation: Quiz student on procedure for determining liming rates and observe liming practices put into use of their home farms

IV. REFERENCES:

- A. Your Limestone Recommendation (St-2)
- B. Understanding Your Soil Test Report (Pm 429)

HOW TO DETERMINE PROPER LIMING RATES

STEPS

KEY POINTS

1. Select appropriate calcium carbonate from soil test report
 - a. Reduction of soil acidity to pH of 6.5 is sufficient for establishment of legume seedlings.
 - b. Reduction to near neutrality will give maximum alfalfa yields and will not limit yields of other crops.
2. Determine the effectiveness of the limestone materials to be used:
 - a. Secure calcium carbonate equivalent and percent of limestone available based on fineness from your limes vendor, local ASCS office or county extension office.
 - b. The effectiveness of any limestone is based on percent ECCE times percent available based on limeness.
 - c. Example: $.90 \text{ ECCE} \times .70 \text{ available based on fineness} \times 100 = 63\%$ total effective limestone
3. Determine the pounds of limestone required to meet the calcium carbonate recommendation
 - a. Divide recommended rate of calcium carbonate by the percent effectiveness of the limestone materials to be used.
 - b. Example: $4000\text{-pound recommendation} \div 100 \text{ percent calcium carbonate} \div 63\% \text{ total effective limestone} = 6,349 \text{ pounds of limestone needed.}$
4. Adjust for previous application of limestone
 - a. Within 6 months after application deduct the full amount previously applied from the recommended rate.
 - b. One year after application, deduct one-half of the amount previously applied from the recommended rate.
 - c. Two years after application, deduct one-fourth of the limestone previously applied from the recommended rate.
 - d. More than 2 years after application use the recommended rate.

HOW TO INTERPRET THE SOIL TEST REPORT

I. OBJECTIVES:

A. To develop the ability to:

1. Select the correct soil test nutrient recommendation
2. Adjust soil test recommendations to specific crop yields

II. EQUIPMENT AND MATERIALS NEEDED:

Soil test report from soil testing laboratory

III. PROCEDURE:

A. Preparation:

1. Teacher - Be familiar with soil test report and know how to interpret the report.
2. Student - Assign the following reading to be completed prior to observing the demonstration.

- a. Understanding Your Soil Test Report (Pm-429) pp. 1-4
- b. Soil Test Report (St-9)

B. Motivation: Discuss the following questions with the class:

1. Why are there two different recommendations given on the soil test report?
2. Why would you want to adjust the soil test recommendations?

C. Presentation: Demonstrate how to interpret a soil test report using the soil test report provided and following the procedure outlined on the attached page:

D. Application: Have students interpret soil test reports for tests taken on their home farms. Some students might bring soil test reports for their home farms and interpret them to the class.

E. Evaluation: Review with the students how to select the correct nutrient recommendation the class period following the demonstration. Observe how students use the soil test reports they have for their home farms.

IV. REFERENCES:

- A. Understanding Your Soil Test Report (Pm-429) pp.1-4
- B. Soil Test Report (St-9)

HOW TO INTERPRET THE ¹⁵⁵SOIL TEST REPORT

STEPS

KEY POINTS

1. What does the soil test measure?
 - a. Elemental phosphorous
 - b. Elemental potassium
 - c. Soil acidity (buffer pH)
 - d. No test for nitrogen, nitrogen recommendations based on specific crop need.
2. Select proper nutrient rate from the soil test report
 - a. Use HIGH level for good management, favorable subsoil moisture and maximum net return per acre.
 - b. Select MEDIUM level for average management limited money situations, adverse moisture conditions and for highest return per dollar spent for fertilizer.
3. Adjust recommendations for yield goals
 - a. HIGH level recommendations are for yields up to 135 bushels of corn and 4 ton of alfalfa per acre.
 - b. For yields above these, adjust recommendations according to the table on the back of the soil test report.
4. Add K₂O (potash) for corn if preceded by corn silage or hay
 - a. For a low potassium test add 25 lbs. of K₂O.
 - b. For a very low potassium test add 35 lbs. of K₂O.

HOW TO ADJUST SOIL TEST REPORT FOR NUTRIENT
CARRYOVER IN THE SOIL

I. OBJECTIVES:

A. To develop the ability to estimate:

1. The nitrogen credits for first or second corn following legume.
2. The amount of carryover available from fertilizer applied the previous year.
3. The amount of nutrients supplied from manure that has been applied since soil was sampled.

II. EQUIPMENT AND MATERIALS NEEDED:

Completed soil test report from soil testing laboratory

III. PROCEDURE:

A. Preparation:

1. Teacher - Be familiar with the procedure for adjusting soil test report for the amounts of nutrients available in the soil.
Have an example worked out prior to class time.
2. Student - Assign the following reading to be completed prior to observing the demonstration:
 - a. Understanding Your Soil Test Report (Pm-429) pp. 1-4
 - b. Modern Farmers Need to be Accountants in the Cornfield (FS-1049)

B. Motivation: Discuss the following questions with the class:

1. What are some factors that might effect the amount of nitrogen carryover in the soil?
2. What are some factors that might effect the amount of carryover of phosphorous and potassium in the soil?

C. Presentation: Demonstrate how to adjust the soil test report for nutrient carryover in the soil using the soil test report provided and following the attached outline:

D. Application: Have students adjust soil test recommendation for their home farms for nutrient carryover.

E. Evaluation: Review with students the factors that effect nutrient carryover and observe their use of soil test recommendations by students on their home farms.

IV. REFERENCES:

- A. Understanding Your Soil Test Report (Pm-429) pp. 1-4
- B. Modern Farmers Need to be Accountants in the Cornfield (FS-1049)

HOW TO ADJUST SOIL TEST REPORT FOR NUTRIENT CARRYOVER IN THE SOIL

STEPS

KEY POINTS

1. Estimate legume credit for nitrogen if less than 3rd year following a legume
 - a. Look up N credit in table 1 on page 3 of Pm-429 or in FS-1049.
 - b. Subtract table value from nitrogen recommendation of soil test report.
2. Allow for carryover N if applied to corn the previous year
 - a. Use table 2 on page 3 of Pm-429 or table 4 in FS-1049.
 - b. Subtract table value from nitrogen recommendation of soil test report.
3. Allow credit for manure applied since soil was sampled
 - a. Use table 3 on page 3 of Pm-429 or table 2 in FS-1049 to obtain average N, P₂O₅ and K₂O credits per ton of manure applied.
 - b. Use table 4 on page 3 of Pm-429 to estimate tons of manure applied.
 - c. Multiple nutrient credit per ton times the tons of manure applied per acre to obtain total nutrient credit of manure applied.
 - d. Subtract total nutrient credits for manure applied from the soil test recommendation.
4. Allow for P and K carryover from fertilizer and manure
 - a. To raise soil test levels at a faster than normal rate omit this.
 - b. Use table 2 on page 3 of Pm-429 to obtain carryover credit.
 - c. Subtract table value of P and K credit from soil test recommended.

WHAT'S IN THE FERTILIZER BAG?

I. OBJECTIVES:

- A. to develop an understanding of the composition of commercial fertilizers:
- B. To develop the ability to:
 - 1. Convert P_2O_5 to phosphorous
 - 2. Convert K_2O to potassium

II. EQUIPMENT AND MATERIALS NEEDED:

- A. Fertilizer bag
- B. Fertilizer bag visuals for magnetic board

III. PROCEDURE:

A. Preparation

- 1. Teacher - Secure a fertilizer bag prior to class, be familiar with conversion factors
- 2. Student - Assign the following reading to be completed prior to class.
 - a. Understanding Your Soil Test Report, (Pm-429) pp. 2-4
 - b. Better Names for "Phosphate" and "Potash" (FS-1050)
 - c. Our Land and its Care, pp. 56 & 57

B. Motivation: Show students a fertilizer bag and ask them the following question:

- 1. If the contents of this bag were applied to a field how many pounds of each of the following elements would be applied to the field?
Nitrogen, phosphorous, and potassium

C. Presentation: Demonstrate how to determine the active nutrients in a bag of fertilizer following the attached outline:

D. Application: Get students several different grades of fertilizer from which to determine amounts of actual nutrients.

IV. REFERENCES:

- A. Understanding Your Soil Test Report (Pm-429) pp. 2-4
- B. Better Names for "Phosphate" and "Potash" (FS-1050)
- C. Our Land and its Care, pp. 56 & 57

WHAT'S IN THE FERTILIZER BAG?

STEPS

KEY POINTS

1. What does a 100# bag of 5-20-20 fertilizer contain?
 - a. 5 lbs. of nitrogen
 - b. 20 lbs. of P_2O_5
 - c. 20 lbs. of K_2O
2. Why can't we buy just pure nitrogen, phosphorous and potassium?
 - a. N, P & K are not stable in their elemental form.
 - b. Must use an oxide form to have a stable product
3. In what form do we find the N, P & K in a 100# bag of 5-20-20 fertilizer/
 - a. N - Ammonium nitrate
Ammonium sulfate
Ammoniating solution
 - b. P_2O_5 - 6% super phosphate
45% Triple superphosphate
60% Calcium Metaphosphate
 - c. K - K_2O muriate of potash

HOW TO CHANGE NUTRIENT RECOMMENDATIONS INTO
AMOUNTS FO A FERTILIZER GRADE

I. OBJECTIVES:

- A. Develop an understanding of the major sources of fertilizer materials in the community
- B. To develop an ability to:
 - 1. Change nutrient recommendations into amounts of a fertilizer grade.
 - 2. Select fertilizer materials that will fulfill nutrient needs.

II. EQUIPMENT AND MATERIALS NEEDED:

- A. Chalkboard and chalk
- B. List of major fertilizers available in the community

III. PROCEDURE:

A. Preparation:

- 1. Teacher - Be familiar with procedure for calculating amounts of fertilizer needed and have an example worked out prior to demonstrating.
- 2. Student - Assign the following reading to be completed prior to observing the demonstration.

- a. Our Land and its Care, pp. 44-45
- b. Understanding Your Soil Test Report (Pm-429) pp. 5-6

B. Motivation: Ask the students the following questions:

- 1. If your soil test recommednations called for 82# of nitrogen how many pounds of anhydrous amonia would you apply?
- 2. Why is it necessary to change fertilizer recommendations into amounts of a fertilizer material:

C. Presentation: Demonstrate how to convert fertilizer recommendations into amounts of a fertilizer grade following the attached procedure:

D. Application: Have students meet a fertilizer recommendation using several different fertilizer sources.

E. Evaluation: Quiz students on how to convert fertilizer recommendations into amounts of a fertilizer grade. Observe how they determine how much fertilizer to apply to their farming programs and on their home farms.

IV. REFERENCES:

- A. Understanding Your Soil Test Report. (Pm-429) pp.5-6
- B. Our Land and its Care, pp. 44-45

HOW TO CHANGE NUTRIENT RECOMMENDATIONS INTO AMOUNTS OF A FERTILIZER GRADE

STEPS

KEY POINTS

1. Express fertilizer requirements and fertilizer grades in same form
 - a. Phosphorous and potassium can be expressed in either the elemental or oxide(P_2O_5) (K_2O) form.
 - b. Use conversion table in extension bulletin FS-1050 to convert from oxide to elemental or vise versa or convert using factors given on page 2 of Pm-429.
 - c. It doesn't matter which form you use.
2. Calculate pounds of fertilizer needed
 - a. Divide actual amount of nutrient needed per acre in elemental form by fertilizer grade expressed in elemental form to get application rate per acre of fertilizer material.
Example:
100lbs./acre of N needed divided by 82% anhydrous amonia = 122 lbs. of anhydrous amonia needed to supply 100 lbs. of elemental nitrogen.
 - b. Divide actual amount of nutrient needed per acre in oxide form by fertilizer grade expressed in oxide form to obtain application rate per acre of fertilizer material.
Example?
 $\frac{80\# P_2O_5}{0-46-0} = 174$ pounds of 0-46-0 per acre

PRINCIPLES OF OPERATION OF A FOUR-CYCLE ENGINE

I. OBJECTIVES: To develop an understanding of:

- A. Intake stroke, compression stroke, power stroke and exhaust stroke in a four-cycle engine
- B. Principles of operation of a four-cycle engine.

II. EQUIPMENT AND MATERIALS NEEDED:

- A. Four-cycle small gasoline engine with head removed so top of piston and valves are visible
- B. Chalk or marking pencil for identifying intake and exhaust valves
- C. Briggs & Stratton Chart No. 1

III. PROCEDURE:

A. Preparation:

- 1. Teacher - Clean up engine and remove head prior to class, fasten cardboard circle in side of engine and fasten a pointer on the crank shaft
- 2. Student - Assign reading of following to be completed prior to the class period during which the demonstration is given:

- a. General Theories of Operation, Briggs & Stratton pp. 2-3
- b. Small Gasoline Engines Student Handbook, pp. 1-2

B. Motivation: Ask the class the following questions:

- 1. What makes an engine run?
- 2. Why is this engine called a four-cycle engine?
- 3. How does the gasoline get into the cylinder?
- 4. Where does the exhaust come from?

C. Presentation: Demonstrate to the class the four strokes following the attached operation break-down and using the small gasoline engine. Arrange for students to stand so all can observe.

D. Application: Pick a student and have him explain the four strokes while he demonstrates them with small gasoline engine. Have the rest of the class evaluate to see if he explains the strokes correctly. If necessary select a second student and have him repeat the demonstration.

E. Evaluation: Quiz students on the following class period to see if they can identify the four strokes and explain what happens during each one.

IV. REFERENCES:

- A. General Theories of Operation, Briggs & Stratton, Corp., pp. 2-3
- B. Small Gasoline Engines Student Handbook. Penn. State Univ. pp. 1-2

PRINCIPLES OF OPERATION OF A FOUR-CYCLE ENGINE

STEPS	KEY POINTS
1. Identify main parts of engine involved	<ul style="list-style-type: none">a. Cylinderb. Pistonc. Intake valve(mark to identify)d. Exhaust valve(mark to identify)
2. Explain intake stroke	<ul style="list-style-type: none">a. Exhaust valve is closed.b. Intake valve is openc. Piston moves downward drawing in air-fuel mixture.d. Mark beginning and end of intake stroke on timing diagram.
3. Explain compression stroke	<ul style="list-style-type: none">a. Exhaust valve remains closed.b. Intake valve closes.c. Piston moves upward greatly compressing air-fuel mixture.d. Mark beginning and end of compression stroke on timing diagram.
4. Explain power stroke	<ul style="list-style-type: none">a. Exhaust valve remains closed.b. Intake valve remains closed.c. Spark occurs igniting air-fuel mixture, force of expanding gases pushes piston down.d. Mark the beginning and end of power stroke on timing diagram.
5. Explain exhaust stroke	<ul style="list-style-type: none">a. Intake valve remains closed.b. Exhaust valve opens.c. Upward movement of piston forces burnt gases out of cylinder through exhaust valve.d. Mark beginning and end of exhaust stroke on timing diagram.

PRINCIPLES OF OPERATION OF A TWO-CYCLE ENGINE

I. OBJECTIVE:

To develop an understanding of the principles of operation of the two-cycle engine.

II. EQUIPMENT AND MATERIALS NEEDED:

Cut-away mock-up of a two-cycle engine

III. PROCEDURE:

A. Preparation:

1. Teacher - Be familiar with principles of operation of two-cycle engine.
2. Student - Assign following to be read prior to class period during which the demonstration is given:

a. Small Gasoline Engines Student Handbook, pp. 2-3

B. Motivation: Ask the class the following questions:

1. How does a two-cycle engine differ from a four-cycle engine?
2. What are the advantages of a two-cycle engine over a four-cycle engine?
3. What are the disadvantages of a two-cycle engine?

C. Presentation: Demonstrate to the class the operation of the two-cycle engine using cut-away mock-up of two-cycle engine and following operation breakdown on the attached page.

D. Application: Select a student from the class and have him explain the operation of a two-cycle engine while demonstrating it. Then select a second student to explain operation while a third student demonstrates.

E. Evaluation: Quiz the students at beginning of next class period to see if they can explain the cycles of operation.

IV. REFERENCE:

A. Small Gasoline Engines Student Handbook, Penn. State Univ. pp. 2-3

PRINCIPLES OF OPERATION OF A TWO-CYCLE ENGINE

STEPS	KEY POINTS
1. Identify main parts of engine involved	<ul style="list-style-type: none">a. Cylinderb. Pistonc. Intake Portd. Exhaust Porte. Crank casef. Reed valve(fuel inlet valve)
2. Explain power stroke	<ul style="list-style-type: none">a. Compressed air-fuel mixture is ignited and expands driving piston down wall.b. Piston uncovers exhaust port first allowing exhaust gases to escape and then intake portc. Piston compresses fuel mixture in crankcase as it moves downward.d. The resulting pressure closes fuel inlet valve and forces fuel mixture inside crank case through intake port into the combustion chamber.
3. Explain compression stroke	<ul style="list-style-type: none">a. As the piston moves upward it covers the intake and exhaust ports and compresses fuel mixture in the combustion chamber.b. At the same time, the pump like action of the piston moving upward from the crankcase creates a vacuum in the crankcase.c. This vacuum draws the fuel inlet valve open, allowing fuel vapor to enter the crankcase from the carburator.

HOW TO CALCULATE PISTON DISPLACEMENT

I. OBJECTIVES: To develop an understanding of:

- A. What bore, stroke and displacement measure
- B. How to calculate piston displacement

II. EQUIPMENT AND MATERIALS NEEDED:

- A. Four-cycle small gasoline engine with head removed so the top of the piston and valves are visible.
- B. A chalkboard and chalk
- C. Depth gauge and ruler
- D. Briggs & Stratton Chart No. 2

III. PROCEDURE:

A. Preparation:

- 1. Teacher- Have engine clean and remove head prior to class. Be familiar with procedure for calculating piston displacement.
- 2. Student - Assign the reading of the following to be completed prior to the class period during which the demonstration is given:
 - a. General Theories of Operations, Briggs & Stratton, pp. 4
 - b. Small Gasoline Engines Student Handbook, pp. 4

B. Motivation: Ask the class the following question:

- 1. What is piston displacement an indication of?

C. Presentation: Using the small gasoline engine, the Briggs & Stratton Chart No. 2 and a chalkboard, demonstrate the procedure for calculating piston displacement following the job break down given on the following page:

D. Application: Have students figure displacements for several different small gasoline engines.

IV. REFERENCES:

- A. General Theories of Operation, Briggs & Stratton, Corp., p. 4
- B. Small Gasoline Engines Student Handbook, Penn. State Univ., p. 4

HOW TO CALCULATE PISTON DISPLACEMENT

STEPS

KEY POINTS

1. Identify the bore, stroke and displacement on the engine
 - a. Bore - diameter of cylinder
 - b. Stroke - distance the piston travels from top dead center to bottom dead center.
 - c. Displacement - Volume which the piston displaces when moving from T.D.C. to B.D.C.
2. Obtain the bore and stroke for engine
 - a. Measure the bore and the stroke directly on the engine.
 - b. Obtain specification from operator's manual or name plate.
3. Compute displacement
 - a. $\text{Displacement} = \frac{(\text{Bore})^2}{4} \times \text{Stroke}$
 - b. As can be seen, the bigger the bore and the longer the stroke the greater the displacement.

I. OBJECTIVES:

- A. To develop an understanding of:
 - 1. Valve operating conditions
 - 2. Valve failures
- B. To develop an ability to:
 - 1. Identify parts of valve train
 - 2. Determine usable valve margin and valve seat tolerances

II. EQUIPMENT AND MATERIALS NEEDED:

- A. Four-cycle small gasoline engine with head removed, feeler gauge, valve spring releaser, measuring guage calibrated to 64th's and needle nose pliers.
- B. Briggs & Stratton Charts No.'s 3 and 4

III. PROCEDURE:

A. Preparation:

- 1. Teacher - Have tools and materials ready and be familiar with procedure for removing valves and measuring margins and valve seat tolerances.
- 2. Student - Assign reading of following references to be completed prior to observing demonstration.
 - a. General Theories of Operation, Briggs & Stratton, pp. 4-7
 - b. Small Gasoline Engines Student Handbook, Penn. State Univ., pp. 5-7

B. Motivation: Use Briggs & Stratton Chart No's 3 and 4 and discuss following with the students prior to giving demonstration:

- 1. What do valves do?
- 2. Under what conditions do valves operate?
- 3. What are some of the common causes of valve failure?

C. Presentation: Demonstrate measurement of valve margin and valve seat tolerances while following the steps outlined on the attached procedure outline:

D. Application: Have students each measure margin on a valve to determine whether the valve is usable. Also have them practice measuring the valve seat tolerances to determine if new valve seats are needed. If possible have students work in small groups or pairs and remove valves from an engine and measure the margin and valve seat tolerances.

- E. Evaluation: Quiz students on the parts of the valve and valve train. The students ability to determine whether a valve is usable or not and his ability to determine valve seat tolerances can be evaluated.

IV. REFERENCES:

- A. General Theories of Operation, Briggs & Stratton, Corp., pp. 4-7
- B. Small Gasoline Engines Student Handbook, Penn. State Univ., pp. 5-7

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HOW TO DETERMINE USABLE VALVE MARGIN AND VALVE SEAT TOLERANCES

STEPS	KEY POINTS
1. Check tappet clearance	<ul style="list-style-type: none">a. Improper tappet clearance will cause valve to become hot by holding it openb. Turn crankshaft until one of valves is at highest position; then turn crankshaft one revolutionc. Insert feeler guaged. Repeat procedure for other valvee. Consult operators manual for required clearancesf. Grind or file off end of valve stem if necessary to obtain proper clearanceg. Valve clearance should always be re-checked when grinding or installation of new valves
2. Remove valves from engine	<ul style="list-style-type: none">a. Remove cover from side of engine that covers valve stems and springsb. Compress valve springs with releaserc. Remove valve spring retainerd. Slide valve up out of valve guide
3. Identify important parts of valve and valve train	<ul style="list-style-type: none">a. Valve springb. Valve guidec. Valve spring retainerd. Valve<ul style="list-style-type: none">(1) head(2) margin(3) face(4) steme. Valve seat
4. Measure valve margin	<ul style="list-style-type: none">a. Margin is edge of valve headb. Valve should be discarded when margin becomes less than $\frac{1}{2}$ of original thicknessc. Margin on most new small engines is $\frac{1}{32}$ of an inchd. Valve with too thin a margin will not be able to withstand heat and will crack and burn
5. Measure valve seat width	<ul style="list-style-type: none">a. Check manual for recommended seat width ($\frac{3}{64}$ - $\frac{1}{16}$ for Briggs & Stratton engines)b. Valve seat should be in the center of valve facec. Valve lapping should be complete for maximum cooling of valve

HOW TO MEASURE VARIOUS RING CLEARANCES

I. OBJECTIVES:

- A. To develop an understanding of:
 - 1. The purpose of rings
 - 2. Ring types and each's function
- B. To develop an ability to:
 - 1. Measure various ring clearances
 - 2. Identify types of rings

II. EQUIPMENT AND MATERIALS NEEDED:

- A. A piston and rings from small gas engine
- B. A feeler guage
- C. A ring expander tool

III. PROCEDURE:

A. Preparation:

- 1. Teacher - Remove piston from engine and rings from piton prior to class time and have all tools and materials needed assembled.
- 2. Student - Assign the following reading to be completed before observing the demonstration:

- a. Small Gasoline Engines Student Handbook, Penn. State Univ., pp. 8-11

B. Motivation: Discuss the following with the students prior to giving the demonstration:

- 1. What is the purpose of the piston rings?
- 2. How can you tell when the rings are becoming worn?
- 3. What are the different types of rings?

C. Presentation: Demonstrate how to measure ring clearances following the procedure outlined on the following page:

D. Application: Have students practice measuring ring gap and clearance on several rings and pistons.

E. Evaluation: Quiz the students on the types of rings and their function at the beginning of the next class. The ability of the students to measure ring gap and groove clearance can also be evaluated.

IV. REFERENCES:

- A. Small Gasoline Engines Student Handbook, Penn. State Univ., pp. 8-11

HOW TO MEASURE VARIOUS RING CLEARANCES

STEPS	KEY POINTS
1. Identify the different rings	<ul style="list-style-type: none">a. Upper compression ringb. Middle compression and scraper ringc. Oil ring
2. Measure the piston ring gap	<ul style="list-style-type: none">a. Insert the rings one at a time one inch down in the cylinder.b. Use a feeler guage to check the gap or end clearance.c. If ring gap is greater than the manufacturer's recommendation, the ring should be discarded.
3. Measure the ring groove clearance	<ul style="list-style-type: none">a. Clean the piston ring grooves thoroughly.b. Place a ring in the top groove of the piston by using a ring expander tool.c. Check remaining space in the groove with a feeler guage.d. If the clearance is greater than the manufacturer's recommendation(usually about .006") a new piston is needed.

HOW TO READ A MICROMETER

I. OBJECTIVE:

To develop an ability to read a micrometer:

II. EQUIPMENT AND MATERIALS NEEDED:

- A. A micrometer and several items to measure
- B. Valve stem
- C. Crankshaft
- D. Crankpin
- E. Large chart showing parts of micrometer

III. PROCEDURE:

A. Preparation:

- 1. Teacher - Be familiar with micrometer and know how to read it.
- 2. Student - Assign the reading of the following prior to observing the demonstration:

a. Small Gasoline Engines Student Handbook, Penn. State Univ., pp. 12-19

- B. Motivation: Show students a crankshaft and ask if any of them can measure the diameter on the crankpin of the crankshaft. Ask them what measuring device they would use. If they select the micrometer, ask them how to read it.
- C. Presentation: Demonstrate how to read a micrometer following the procedure given on the attached page:
- D. Application: Have students practice using the micrometer to measure parts of a small gasoline engine such as a crankshaft, crankpin, valve stem and bearing journal. Have students read diagrams of the micrometer on page 24 of the reference.
- E. Evaluation: Review the students at the beginning of the next class period on how to read the micrometer. Observe the students use of the micrometer in the laboratory exercises involving small gasoline engines.

IV. REFERENCES:

- A. Small Gasoline Engines Student Handbook, Penn State Univ., pp. 12-19

HOW TO READ A MICROMETER

STEPS	KEY POINTS
1. Identify the major parts of the micrometer	<ul style="list-style-type: none"> a. Anvil b. Spindle c. Sleeve d. Thimble e. Size of the micrometer
2. Use micrometer to measure a shaft, valve stem or other object	<ul style="list-style-type: none"> a. Turn thimble to close spindle towards anvil. b. Close micrometer until it touches the object with both anvil and spindle. DO NOT CLOSE TOO TIGHT! c. Remove micrometer from the object.
3. Read the scale on the sleeve of the micrometer first	<ul style="list-style-type: none"> a. Each mark on the sleeve is .025". b. Every fourth line on the sleeve is a little longer than the others and is stamped 1, 2, 3, etc. meaning .100", .200", .300", etc.
4. Read the scale on the thimble	<ul style="list-style-type: none"> a. One complete revolution of the thimble is equal to .025" on the sleeve. b. For each turn of the thimble it moves and marks the sleeve. c. Each mark on the thimble represents .001".
5. Determine the total width the micrometer is open	<ul style="list-style-type: none"> a. Add reading on sleeve to the reading on the thimble. b. If the sleeve readings are .500" and .050" and the thimble reading is .012" the total is $.500" + .050" + .012" = .562"$.

HOW A CARBURETOR WORKS

I. OBJECTIVES:

A. To develop an understanding of:

1. Principles of operation of the carburetors
2. How gaseous mixtures are controlled within the carburetor.

B. To develop the ability to:

1. Identify basic parts of the carburetor
2. Explain the operation of various types of carburation.

II. EQUIPMENT AND MATERIALS NEEDED:

- A. A gravity feed carburetor
- B. A suction feed carburetor
- C. Briggs & Stratton Charts No's 5, 7, 8, 9, 10 and 11
- D. A spool, peice of cardboard and a common straight pin
- E. A magnetic board and magnets..

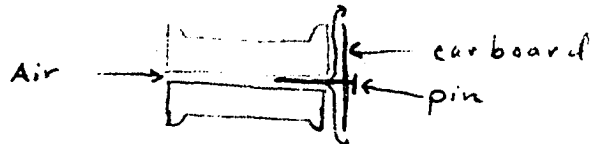
III. PROCEDURE:

A. Preparation:

1. Teacher - Be familiar with the operation of the carburetor and the difference between a suction and gravity feed carburetor.
2. Student - Assign the following reading assignment to be completed prior to observing the demonstration:
 - a. General Theories of Operation, Briggs & Stratton, Corp., pp. 8-13
 - b. Small Gasoline Engines Student Handbook, Penn State Univ., pp. 27-37

B. Motivation:

1. Take an ordinary(thread)spool and place a piece of cardboard one inch square across the end of the spool, then take a common straight pin and stick it through the center of the cardboard and into the hole of the spool. The cardboard then lies flat across the end of the spool and the pin prevents the cardboard from sliding sideways. Now, holding the card in place momentarily, blow steadily through the hole on the other end of the spool. (The cardboard does not blow away and the harder you blow, the closer the card sticks.)



2. Use the Briggs and Stratton chart no. 5 to show the function of the venturi.

- C. Presentation: Demonstrate how a gravity feed carburetor functions using the magnetic board, Briggs and Stratton chart no. 8 and following the procedure outlined on the attached page:
- D. Application: Have students identify the parts of a carburetor on the actual carburetor. Select one or two students and have them explain the flow of air and fuel through the carburetor using the magnetic board. Have the students do Classroom Exercise II on pages 40 - 42 of the Small Gasoline Engines Student Handbook.

IV. REFERENCES:

- A. General Theories of Operation, Briggs & Stratton, Corp., pp. 8-13, 20-21.
- B. Small Gasoline Engines Student Handbook, Penn. State Univ., pp. 27-37.

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HOW A CARBURETOR WORKS

STEPS	KEY POINTS
1. Identify the functional parts of the carburetor	<ul style="list-style-type: none">a. Needle valveb. Floatc. Float valved. Throttlee. Chokef. Idle valveg. Venturih. Nozzle
2. Flow of fuel and air in the carburetor when the engine is being choked for starting	<ul style="list-style-type: none">a. The throttle valve is openb. The choke valve is closed, restricting the air flow through the venturic. A vacuum is formed in the carburetor throat, thus causing additional fuel to be sucked out of the nozzle
3. The flow of fuel and air in the carburetor when the engine is idling	<ul style="list-style-type: none">a. The throttle valve is closedb. The choke valve is openc. Fuel moves through the nozzle into the idle chamberd. The idle chamber leads into the carburetor just beyond the throttle plate
4. The flow of air and fuel in the carburetor at full throttle	<ul style="list-style-type: none">a. The throttle valve is openb. The choke valve is openc. Fuel moves out of the nozzle into the carburetor throat just beyond the venturi where it mixes with the aird. Air also moves through the vent pipe to maintain atmospheric pressure in the float chambere. The air moves past the choke valve, through the venturi causing a low pressure area

HOW A MAGNETO IGNITION SYSTEM WORKS

I. OBJECTIVES:

A. To develop an understanding of:

1. The purpose of ignition systems
2. Principle of magneto-ignition systems
3. A complete magneto cycle

B. To develop an ability to identify the parts of a magneto-ignition system:

II. EQUIPMENT AND MATERIALS NEEDED:

- A. One four-cycle small gasoline engine
- B. Tools for removing fly wheel and shroud
- C. Briggs & Stratton flip-over charts
- D. Magnetic board and magnets
- E. Briggs & Stratton Charts No.'s 15, 16, 17, 18, 19 and 20

III. PROCEDURE:

A. Preparation:

1. Teacher - Befamiliar with principles of a magneto-ignition system and the parts of a magneto-ignition system. Remove flywheel and shroud from engine prior to class.
2. Student - Assign the following reading assignment to be completed prior to observing the demonstration:

- a. General Theories of Operation, Briggs & Stratton Corp., pp. 15-18
- b. Small Gasoline Engines Student Handbook, Penn. State Univ., pp. 45-51

B. Motivation: Ask the students the following questions:

1. How many volts of electricity jump the spark plug gap on a small gasoline engine?
2. How does this compare with the voltage of a ordinary electrical outlet?

BRING OUT: There are 10,000 volts at the spark plug which is about ten times the voltage of a common electric outlet.

3. How can the magneto-ignition system develop this amount of voltage?

C. Presentation: Demonstrate a complete magneto cycle using the small gasoline engine, the flip charts and following the procedure outlined on the attached page:

D. Application: Have several students trace through the complete magneto cycle using first the flip charts and then the engine. Have students do classroom exercise III on page 52 and 53 of the Small Gasoline Engines Student Handbook.

IV. REFERENCES:

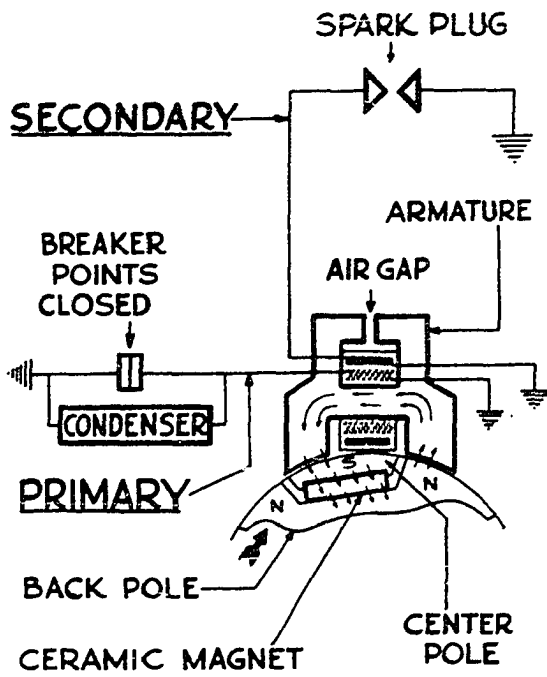
- A. General Theories of Operation, Briggs & Stratton Corp., pp. 15-18
- B. Small Gasoline Engines Student Handbook, Penn. State Univ., pp. 45-51

HOW A MAGNETO IGNITION SYSTEM WORKS

STEPS

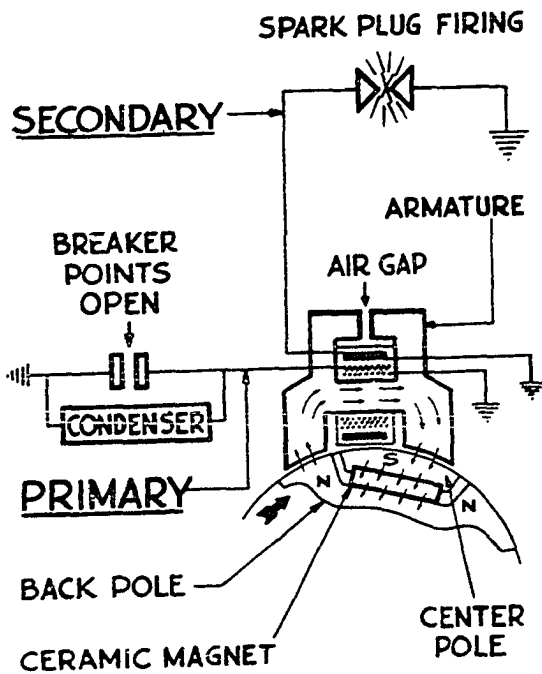
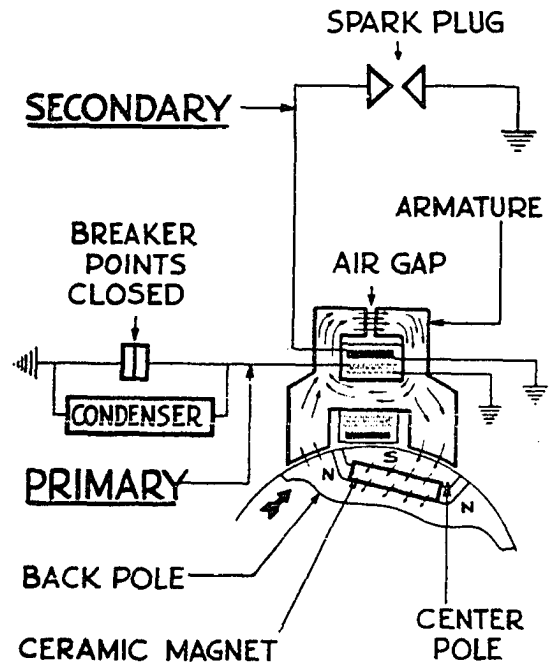
KEY POINTS

1. Identify the parts of the magneto-ignition system (B & S Chart No. 15)
 - a. Identify major parts on flip chart no. 15
 - b. Identify the following parts on the engine:
 1. Sparkplug
 2. Sparkplug wire
 3. Armature
 4. Coil
 5. Magnet
 6. Flat on crankshaft or crankshaft lobe
 7. Coil
 8. Spring
 9. Plunger
 10. Breaker point
 11. Primary circuit
 12. Secondary circuit
2. The magnet on the flywheel approaches the armature (B & S Chart No. 16)
 - a. The breaker points are closed.
 - b. No current flowing in either the primary or secondary circuit.
 - c. The magnetic field flows counter-clockwise from the magnet through the lower part of the armature.
3. The flywheel rotates to the position in the second diagram. (B & S Chart No. 17)
 - a. The breaker points are still closed.
 - b. The magnetism continues to flow in the same direction and magnitude through the center core.
 - c. The magnetism flows clockwise through the outer portion of the armature and through the top air gap because of the change of flywheel position.
4. The breaker points open (B & S Chart No. 18)
 - a. Current stops flowing in the primary circuit and therefore the electromagnetic effect ceases.
 - b. The magnetism reverses direction of the flow through the lower part of the armature.
 - c. This rapid change in flow of magnetism produces about 170 volts in the primary winding.
 - d. A voltage is also induced in the secondary winding but it is proportional to the turns ratio, i.e., 60 to 1 or 10,000 volts.
 - e. This rapid magnetism change is short and therefore the flow of current across the sparkplug gap is as long as necessary, but short enough to afford long electrode life.



STEP 2 - The magnet on the flywheel approaches the armature.

STEP 3 - The flywheel rotates a little further.



STEP 4 - The breaker points open.

PREVENTIVE MAINTENANCE

I. OBJECTIVES:

A. To develop an understanding of:

1. The importance of maintenance on small gasoline engines.
2. Why clean, fresh, regular gasoline should be used in small gasoline engines.

B. To develop the ability to:

1. Correctly service engine at the proper time.
2. Properly prepare a small gasoline engine for storage.

II. EQUIPMENT AND MATERIALS NEEDED:

- A. Small gasoline engine
- B. Wrench for removing spark plug and flywheel
- C. Wire brush, penknife and solvent for cleaning sparkplug
- D. Point file, flat feeler gauge and round feeler gauge
- E. Engine oil of recommended grade
- F. Tools for working on a small gasoline engine

III. PROCEDURE:

A. Preparation:

1. Teacher - Be familiar with procedure of preventive maintenance and have equipment and materials assembled before hand.
2. Student - Assign the reading of the following before observing the demonstration:

a. Small Gasoline Engines Student Handbook, pp. 55-59

- B. Motivation: Discuss with the students the maintenance they are giving the small gasoline engines they have on their farms. Have the students explain the condition under which the small gasoline engine on their farms operate and compare these conditions with the operating conditions of their cars.

- C. Presentation: Demonstrate preventive maintenance on a small gasoline engine following the procedure outline on the attached pages:

- D. Application: Have students perform maintenance on small gasoline engine they have on their home farms. This may be done at home or in the school shop.

- E. Evaluation: Quiz students on procedure for performing preventive maintenance on small gasoline engines. Observe students in their performance of performing preventive maintenance.

IV. REFERENCE:

- A. Small Gasoline Engines Student Handbook, Penn. State Univ., pp. 55-59

PREVENTIVE MAINTENANCE

STEPS

KEY POINTS

1. Use a standard brand of clean fresh, regular grade of gasoline
 - a. Regular gasolines have sufficient octane ratings for the compression ratio.
 - b. Premium grade gasoline may cause a vapor lock in the fuel line when the engine becomes hot.
 - c. Use of highly blended gasoline is not recommended, as it will leave deposits in the engine and shorten engine life.

2. Oil should be changed every 25 hours of operation
 - a. This will remove the dirt and foreign material that has found its way into the engine.
 - b. High grade, heavy duty detergent type oil is recommended for most small gasoline engines (A.P.I. MS or MM)
 - c. The following SAE grades are recommended for seasonal operation where temperatures are:
 - Above 32F - SAE 30
 - 32F to 0F - SAE 10W
 - Below 0F - SAE 5W

3. Service air cleaner regularly
 - a. The required frequency of cleaning depends on operating conditions.
 1. 25 hours of engine operation in relatively dust free operation
 2. To several times a day in dusty condition
 - b. To service the oil bath type
 1. Remove old oil
 2. Wash filter element in solvent
 3. Refill bowl to proper level with specified grade of clean oil.
 - c. To service the dry or foam type
 1. Wash in a good commercial solvent
 2. Excess solvent should be blown or shaken from the filter
 3. Re-oil the filter
 4. The paper element should be replaced when servicing the dry element type

4. Clean and regap spark plugs once each 100 hours of operation
 - a. Clean spark plugs with a wire brush, pen knife and solvent
 - b. File surfaces of electrodes flat with a point file
 - c. Regap sparkplug to engine specifications using a round file gauge on used plugs (A flat gauge can be used on new plugs)

STEPS

KEY POINTS

5. Clean and service the magneto every 100 hours of operation

- a. Clean magneto using compressed air or solvent (Don't submerge coil in solvent)
- b. If breaker points are worn or pitted they should be replaced.
- c. The points can be cleaned using fine energy paper.
- d. Set point gap to engine specifications using a flat guage.

6. Prepare engine for winter storage properly

- a. Drain fuel tank and carburetor; let engine run to make sure all gasoline is out of the fuel systems.
- b. Drain oil from crankcase while engine is still hot, and flush with kerosene. Refill with the proper grade of fresh oil.
- c. Clean exterior of engine.
- d. Service air cleaner.
- e. Spread a light film of oil over any exposed surfaces of engine which are subject to rust and corrosion.
- f. Remove, clean, and regap spark plug.
- g. Pour a tablespoon of oil into sparkplug hole, crank engine slowly by hand, replace spark-plug.
- h. Store engine in a dry place.

HOW TO PREPARE A FINANCIAL STATEMENT

I. OBJECTIVE: To develop the ability to:

- A. Analyze a farming situation and determine the financial position of the applicant.
- B. Prepare a financial statement.

II. EQUIPMENT AND MATERIALS NEEDED:

- A. Financial Statement forms (PCA 436R)
- B. Liabilities and assets of a farmer for illustrative purposes.

III. PROCEDURE:

A. Preparation:

- 1. Teacher- Be familiar with financial statements and have the example worked out ahead of the presentation.
- 2. Student - Assign the following reading assignment to be completed prior to observing the demonstration:

- a. Financing Farm and Ranch Activities, pp. 14-17

B. Motivation: Ask the students the following questions:

- 1. What does a lender look for in a borrower?
- 2. How does a lender assess a borrower's ability to repay a loan?

C. Presentation: Demonstrate to the class how to prepare a financial statement using the data given in the farm credit problem and following the procedure outline on the following page: Have each student fill in the financial statement form as you go along.

D. Application: Have each student figure his own net worth.

E. Evaluation: Quiz students on how to fill out a financial statement. Check to see if the students make a financial statement part of their experience program records.

IV. REFERENCES:

- A. Financing Farm and Ranch Activities, pp. 14-17

HOW TO PREPARE A FINANCIAL STATEMENT

STEPS

KEY POINTS

- | | |
|------------------------------------|--|
| 1. List value of all assets | <ul style="list-style-type: none">a. Estimate value of all livestock owned using current prices.b. Value of grain and feed on hand at the current local market prices.c. Cash on hand or in the bank.d. Value of machinery and equipment owned.e. Value of all real estate owned.f. Other property owned. |
| 2. List amounts of all liabilities | <ul style="list-style-type: none">a. Value and due dates of all short term loans.b. Amounts of unpaid supply accounts.c. Unpaid Taxes(past due)d. Unpaid collateralized loans.e. Farm mortgage loans.f. Other unpaid bills and debts. |
| 3. Determine net worth | <ul style="list-style-type: none">a. Add value of all assets to obtain total assets.b. Add amounts of all liabilities to obtain total liability.c. Subtract total liabilities from total assets. |

HOW TO PREPARE A BUDGET WORKSHEET

I. OBJECTIVES:

- A. To develop an understanding of budgeting principles.
- B. To develop an ability to budget a farm credit problem.

II. EQUIPMENT AND MATERIALS NEEDED:

- A. Budget worksheets
- B. Farm Credit Problem

III. PROCEDURE:

A. Preparation:

- 1. Teacher - Be familiar with budgeting and have an example worked out ahead of the presentation.
- 2. Student - Assign the following reading assignment to be completed prior to class time.

a. Financing Farm and Ranch Activities, pp. 34, 36-37

B. Motivation: Ask the students the following questions:

- 1. What is the purpose of a budget?
- 2. If you were to borrow money for operating costs, how could you convince the lender that you need the amount you are asking for?
- 3. How could you assure a lender that you will be able to repay the loan you are asking for?

C. Presentation: Demonstrate to the class how to prepare a budget using the data given in the farm credit problem and following the attached procedure. Have each student fill in the budget worksheet as you go along.

D. Application: Have the students fill out budget worksheets for their farming programs or home farm operations.

E. Evaluation: Quiz the class on the uses for budget worksheets and observe their use of them in their farming programs.

IV. REFERENCES:

- A. Financing Farm and Ranch Activities, pp. 34, 36-37
- B. The Farm Credit Problem
- C. The Budget Worksheet

HOW TO PREPARE A BUDGET WORKSHEET

STEPS

KEY POINTS

1. Estimate all operating costs and other cash outlay
 - a. Estimate the following operating costs by the month in which they will occur:
 1. Rent
 2. Seed
 3. Fertilizer
 4. Chemicals
 5. Feed
 6. Repairs, gas, oil
 7. Supplies and vet. expenses
 8. Insurance
 9. Utilities
 10. Personal living
 11. livestock bought
 12. Payments on notes
 - b. Total estimated costs by month and by expense.
2. Estimate all sales and other possible sources of income
 - a. Estimate the following sales and sources of income by the month in which they will occur:
 1. Hogs
 2. Cattle
 3. Beans
 4. Corn
 5. Other
 - b. Total estimated income by the month and by the source of income.
3. Determine the amount of capital needed for operation
 - a. Determine net cash flow for each month by subtracting total expenses from total sales for that month.
 - b. Amount of capital needed equals negative net cash flow minus cash on hand.

HOW TO EVALUATE A CREDIT SOURCE

I. OBJECTIVES:

A. To develop an understanding of:

1. The sources of credit
2. Criteria used to evaluate a credit source

B. To develop an ability to determine the type of credit source to use.

II. EQUIPMENT AND MATERIALS NEEDED:

Two or more examples of sources of credit to be evaluated and compared.
(Both should be the same type of loan)

III. PROCEDURE:

A. Preparation:

1. Teacher - Select students to role-play an application for a loan. Have students in their role playing bring out the factors that need to be considered in evaluating a credit source. Have the students role-play the application for the same loan to different sources.
2. Student - Assign the following reading to be completed prior to the demonstration:

a. Financing Farm and Ranch Activities, pp. 17-19, 32-41

B. Motivation: Ask the students the following questions:

1. Does it make any difference where I borrow money?
2. What factors should I consider when evaluating a source of credit?

C. Presentation: Demonstrate by having the students role-play loan applications. Have the students follow the outline of factors to consider on the attached page:

D. Application: Have students evaluate several sources of credit available in the local community

IV. REFERENCE:

- A. Financing Farm and Ranch Activities, pp. 17-19, 32-41

HOW TO EVALUATE A CREDIT SOURCE

STEPS	KEY CONSIDERATIONS
1. Character	<ul style="list-style-type: none">a. Does the lender have a reputation for fairness and honesty in dealing with borrowers?b. Does he have a good understanding of farming and take into account the full needs of a farmer?
2. Lending policies	<ul style="list-style-type: none">a. Has the lender adopted repayment schedules which are fitted to the earnings of the farm and the capacity of the farmer to pay?b. Has the lender been interested enough in the welfare of the deserving borrower to carry loans during temporary periods of low income?
3. Performance and dependability	<ul style="list-style-type: none">a. Will the lender be able and willing to finance the borrower year after year once the farmer has established a credit rating?b. Will the lender finance the farmer through periods of hardship?
4. Experience and knowledge of farming	<ul style="list-style-type: none">a. Does the lender have a broad up-to-date knowledge of farming?b. Is the lender willing to counsel with the borrower concerning his credit needs?
5. Cost of the loan	<ul style="list-style-type: none">a. Is interest charged only on the unpaid balance of the loan?b. Is the "time interest rate" of the loan fair and reasonable?

HOW TO CALCULATE THE TRUE INTEREST RATE OF A LOAN

I. OBJECTIVE:

To develop the ability to calculate the costs of various types of loans.

II. EQUIPMENT AND MATERIALS NEEDED:

A. Chalkboard and chalk

B. Examples of different loans(A bank loan and a finance company loan)

III. PROCEDURE:

A. Preparation:

1. Teacher - Be familiar with the procedure for calculating interests rates and have an example worked out prior to class time.
2. Student - Assign the following reading to be completed prior to class time.

a. Financing Farm and Ranch Activities, pp. 18-19

B. Motivation: Ask the students the following questions:

1. What costs are involved in borrowing money besides the interest rate?
2. What is a discounted loan?
3. What is an amortized loan?

C. Presentation: Demonstrate how to calculate the true interest charge of a loan following the procedure outlined on the attached page and using one of the examples given in the reference material.

D. Application: Have students evaluate the time interest charges for two different sources(for example: a bank loan and finance company)

IV. REFERENCE:

A. Financing Farm and Ranch Activities, pp. 18-19

191 HOW TO CALCULATE THE TRUE INTEREST RATE OF A LOAN

STEPS

KEY POINTS

- | | |
|---|--|
| 1. Calculate total interest charge | <p>a. Determine total amount repaid(number of payments x amount of each payment)</p> <p>b. Subtract principal amount financed from total amount to be repaid to lender.</p> |
| 2. Determine loan or interest charge per year | a. Total loan or interest charge divided by number of years financed. |
| 3. Determine average amount of loan outstanding | <p>a. Usually is $\frac{1}{2}$ of principal amount financed.</p> <p>b. Calculated by $\frac{\text{Principal Amount Financed}}{2}$</p> |
| 4. Calculate true interest charge | <p>a. True interest charge = loan or interest charge per year divided by average amount of loan withstanding.</p> <p>b. If monthly or equal and evenly spaced payments are made, the following formula can be used:</p> $\frac{\text{Total of finance charges}}{\frac{1}{2} \text{ original loan}} \times \frac{\text{number of payments}}{\text{no. years}} \times \frac{1}{\text{no. payments} + 1}$ |

HOW A LENDER EVALUATES A LOAN

I. OBJECTIVE:

- A. To develop an understanding of the criteria used in granting farm credit:
- B. To develop an ability to evaluate a borrower.

II. EQUIPMENT AND MATERIALS NEEDED:

III. PROCEDURE:

A. Preparation:

- 1. Teacher - Select two capable students to role-play the parts of a borrower and a lender. Prepare the students as to what they are to do and the points they should emphasize.
- 2. Student - Assign the following reading to be completed prior to the demonstration:

a. Financing Farm and Ranch Activities, pp. 14-17, 34-35, 44-73

B. Motivation: Present the following situation to the class:

John Porter, a young farmer wanted to install some conservation practices, rebuild some fence and increase the size of his livestock enterprised. John also wants to buy the adjoining 80 acres. Would John be able to borrow the needed money?

BRING OUT: The lender would want to know more about John and his farming operation before making the loan.

- C. Presenation: Have the two students demonstrate an application for a loan from a local banker. Have them emphasize the points on the attached outline and use the situation given in the Farm Credit Problem:
- D. Application: Summarize the points in the outline after the presentation and have each student evaluate himself as a prospective borrower.

IV. REFERENCE:

- A. Financing Farm and Ranch Activities, pp. 14-17, 34-35, 44-73

HOW A LENDER EVALUATES A LOAN

FACTORS	KEY CONSIDERATIONS
1. The man(This information to be given before the start of the role playing)	<ul style="list-style-type: none"> a. Has the farmer demonstrated his ability as a farmer and a manager. b. Has he a past record of honesty and above board relations with all people? c. Has the applicant any unpaid bills of long standing or many small bills?
2. Financial position	<ul style="list-style-type: none"> a. Are his assets greater than his liabilities? b. Has the applicant property that could be quickly sold for cash to pay current expenses and debts? c. Has the applicant listed all debts in his financial statement?
3. Repayment capacity	<ul style="list-style-type: none"> a. Is the business of adequate size to yield an adequate gross income? b. Does the farming operation have efficient production or high yield per unit? c. Are good prices for products to be sold anticipated? d. Does he have low cash production costs? e. Are the cash overhead costs low? f. Is there good home and farm management?
4. Purpose of the loan	<ul style="list-style-type: none"> a. Is the loan for necessities such as production costs? b. If the loan is for needs such as taxes or interest is sufficient capital available for necessities? c. Is the applicants financial position and repayment capacity such as to merit a loan for something that does not add directly to the profit from the business?
5. Security for the loan	<ul style="list-style-type: none"> a. Does the borrower have sufficient assets to provide ample security for the loan? b. Does the applicant have a "high grade credit risk" that would qualify him for a short term loan without giving collateral of any kind?

HOW TO WRITE A CHECK

I. OBJECTIVE:

To develop an ability to correctly write a check:

II. MATERIALS NEEDED:

Check blanks from local bank

III. PROCEDURE:

A. Preparation:

1. Teacher-- Be familiar with the correct procedure for writing a check.
2. Student - Assign the following to be read prior to observing the demonstration:

a. Financing Farm and Ranch Activities, pp. 19-29

B. Motivation: Have students develop a list of advantages for using checks.

C. Presentation: Demonstrate the correct method of writing a check following the procedure outlined on the attached sheet:

D. Application: Have each student write out a check.

IV. REFERENCE:

A. Financing Farm and Ranch Activities, pp. 19-29

HOW TO WRITE A CHECK

STEPS

KEY POINTS

1. Select the type of check to be used
 - a. Form checks - available from the bank where you have your account.
 - b. Personalized checks - available through your bank.
 - c. Universal check blanks - can no longer be used as all checks must have the bank number on them in magnetic ink.
2. Write the check
 - a. Write all checks in ink.
 - b. Write plainly.
 - c. Leave no space between the dollar sign and the amount of the check.
 - d. Do not make checks payable to cash.
 - e. Never sign a blank check.
 - f. If you make a mistake in filling out a check destroy it and write a new one.
 - g. Show for what the check is given.
3. Write VOID across sample checks that are not to be charged